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XUM

THE

JOURNAL OF SCIENCE.

JULY, 1885.

I. "EVOLUTION AS APPLIED TO THE CHEMICAL ELEMENTS."*

By the Count O. REICHENBACH.

THERE was an article in "Nature," Nov. 6th, 1875, where Mr. T. B. Blanchard "supposed" this theory had not been discussed before. In consequence I sent the following paper to the Editor.† It was returned on December 5th, for "in the pursuit" "of the discussion" of the "great principle" "of Darwin," as applied "to the Chemical Elements," a distinguished scientist had informed Dumas, on December 3rd, that he made "observations" "indicating the breaking up of atoms of bodies hitherto regarded as elementary."

Seeing the absence of experimental and metaphysical progress, I contribute this phantasmagoria for the benefit of aspiring alchemists.

It would be hasty to affirm that we cannot succeed in mutating any element, but the metamorphosis of most, or perhaps all, of them may depend—like the creation of organisms—on circumstances and powers beyond our control.

* The article "Recent Developments of Chemical Science," in "Journal of Science" (January, 1885), is the immediate cause of this contribution.

† Written in 1862, preceded by "On the Atom and on Heat" (1861), and followed by "The Origin of Organisms" (1865).

The theory that elements are multiples of H evades proof and disproof, because it attributes observed fractions to experimental errors. But why should a new re-partition of a sum of matter, breaking up the unity H into fractions, not be a requirement of elementary mutation and evolution? Must it not follow from the mutual action and development of cosmic systems and masses? Do atomic weights represent dead weight only? Do they not include a tendency of motion imparted from a distance, and affecting different atoms differently under equal or similar circumstances?

Should we not bear in mind, in framing hypotheses of progressive growth and development of nebulæ, systems, cosmic masses, strata, molecules, and atoms, that looking round on earth, the home of all our experiences, and analysing the lights from heaven, we find some elements universal, others predominant, others frequent, less frequent, rare, and very rare? Must not the extent and frequency of formations correspond to that of causations? Is it, then, rational to represent evolution by an indiscriminate tabulation of elements, according to an assumed law of multiplicity of H?

I do not believe my hypothesis infallible, but in the right direction. I use the atomic weights accepted by Berzelius and Wöhler, except where stated otherwise, without pretending them to be free from error.

Hydrogen and hydrocarbons seem to entirely constitute some nebulæ and comets, masses in a nascent state. Nebulæ consist of gases, liquids, and solids. First H and O, then C and N. These elements compose almost exclusively our atmosphere and ocean, and enter largely in organisms and solids. OH=Aq, exceptional in many respects, is all-present in every form.

The relation of H, O, C, and N without fractions, made into a metaphysical toy, is not without interest. Equivalent H=1 is composed of two atoms, mathematical points grown magnitudes; spaces become force, energy, mutual motion, attraction, and repulsion. Two such points describe and form a straight line, a dimension, of absolute length 2, —the equivalency H. Three such lines combine to a cube of energy, a volume, the space of three dimensions, $2^3=8=O$, oxygen; the volume O coincident with a sphere is equal in size and form to one of the original points become magnitude and force, for the gas volume of H to that of O is =2 : 1.

In weight $8H=O$; $(8+8\div2)H=12=C$;

$(8+8\div2+(8\div2)\div2)H=14=N$.

Observation finds the universal, primary elements,—

$$H=1;\ O=8{\cdot}01307;\ C=12{\cdot}250;\ N=14{\cdot}188.$$

The 0·01307 added to O is little, yet no determination of respective weights has been made more reliably. The 0·01307 represents a tendency of motion, a physical characteristic imparted to the metaphysical O=8 by the generation of our solar system. In 1857, independently of all this, I got as probable relation of planetary to solar mass, as result of an engendering opposition and motion,—

$$1:8{\cdot}8^3=1:681{\cdot}5;$$

the metaphysical H+O became water, the egg of a system,—

$$9\div 681{\cdot}5=0{\cdot}01321.$$

Equal spectra need not represent equal atoms for all systems; they may signify similarly proportioned motions under similar circumstances. Taking C=12·250 we might conjecture C=O+4H+1÷4H with an excess of 0·013. When 8C originated together,—*organically*,*—but one C splitting in two (the now preferred 6·125×2) united with 2O and liberated 0·013×8 from 8C, we get 7C at 12·250 and 2N at 14·188. In this manner we might build up a system. But we keep to the hypothesis applied to H and O; there is parallelism in the development of the system and its elements.†

In dealing with that development and the tension of vapour (*ref.*), I showed the meaning of the fifth power or root. C is the transition between H and O through the organic development within the molecule Aq; it is an organic skeleton,—

$$O\times\sqrt[5]{O}=12{\cdot}260=C.$$

The planetary mass decomposed into two masses, their residues being Jupiter and Saturn; they ejected two others, who divided each into four subordinate masses, split off.

* The great chemist Liebig, affirming elementary eternity, wrote—"The view that elements might be formed in organisms" "belongs to the time of childhood of natural science, but is at present unworthy of it." Is it? Elements may be produced organically and inorganically. Where is the mechanical definition of either?

† *See* "Journal of Science" for February, March, and April, 1883, and "On some Properties of the Earth," 1880. Referring to them I shall write (*ref.*).

In the lawful evolution of the system,—in the distribution of its masses, distances, motions, excentricities, and so forth,—we meet the relations—

$$1 : 1{\cdot}69 = 1 : \sqrt[3]{8{\cdot}013}\,;\ 1{\cdot}72 = \sqrt[3]{9{\cdot}013}\,;\ 1{\cdot}85 = \sqrt[3]{12{\cdot}260}$$

connected and modified by subordinate mutual disturbances. 1·69 :: 1·85 produces the mean term 1·77, and—

$$8{\cdot}013 \times 1{\cdot}77 = 14{\cdot}188 = \mathrm{N}.$$

1·72 = 1·83 ÷ 1·049 (*ref.*) brings C : N = 1 : $1{\cdot}049^3$ (*ref.*). I group the predominant elements in the probable order of contemporaneous, successive, and continuous evolution from the Primaries; continuous, because the preceding elements do not vanish when the later ones increase in the condensing cosmic mass.

	Chlorine.. 35·470	
Sodium ... 23·310	Sulphur... 16·120	Potassium . 39·257
Magnesium 12·686		Aluminium 13·716
Calcium ... 20·515		Silicon ... 22·211
	Iron ... 27·281	

(N × 5) ÷ 2 = 35·470 = Cl. N, circulating by solar action from and to Aq, becomes Cl; five N are made in one, condensed, and split—by organic fission, may be. Cl is, besides the primaries, H, O, N, the one element gaseous under ordinary circumstances, but differs by being coloured.

" If chlorine be compressed, so as to reduce it to a volume five times less than it occupies at the ordinary pressure of the atmosphere, it becomes liquid, with the density 1·33 " (Regnault, Chem.). The pressure which liquefies Cl at ordinary temperature is " four atmospheres " (Graham, Chem.). The gas Cl, with an equivalent and density 2·5 times that of N, reduced to 1 ÷ (2·5 × 2) its volume, becomes liquid when the pressure exceeds that of the atmosphere, as the surface of the Earth exceeds that of the electricity ill-conducting portion, the land, the 1 ÷ 3·83 of the surface; more elevated than the conducting sea, four times when the weight of the whole atmosphere to that of its portion resting on the land is considered. The excess in density, 0·33 of liquefied chlorine over density 1 of water, is 0·33; the addition is therefore 1 ÷ 4 of the density of the new liquid generated in the sea, and corresponds to the preceding relation of atmospheric pressure, of the resisting

non-conductor raised in Aq, whose conduction is increased by the accession of chlorine.*

Chlorine appears to exist through the whole system; when some of these relations seem quite terrestrian, I have shown (*ref.*) that everything terrestrian is, as integral part of the system, thereby determined.

Fractional differences arising in mutation may be compensated by complementary elements, and may therefore be realities, not errors, even if they could not be explained as tendencies of motion and otherwise.

The atmosphere consists almost entirely of O and N; the ocean of H and O; C is met all through. The predominant elements indicate, by the order in which they follow, their quantitative connection with sea or land. The sea contains more Cl than Na, more Na than Mg, more Mg than Ca, more Ca than Ka, more Cl than S. The percentage in the solids is the reverse. Potassium is in the sea combined with Cl, but this Cl is only $1 \div 1773$ of the ocean; such part as solar gravity at the surface of the sea is of g; Ka is $1 \div 3546$, as the mass of the sea is of that of the earth, &c. Ka is more of the land than of the sea.

Sulphur connects ocean and land. Al and Si disappear in the sea. Si is the chief element in the shell; and Fe, not found in sea-water, presumably increases—together with Si, O, and S—in the inner earth.

Sulphur, $16{\cdot}120 = 2O$ condensed; the characteristic, $0{\cdot}013 \times 2$, of the 2O becomes by the distribution of one H or unity $1 \div 8{\cdot}78$ (*ref.*) $= 0{\cdot}114$, and S $16{\cdot}114$. Binoxide of H has a smell resembling that of ozone in formation, which reminds us of that of sulphur, which is that of the atmosphere after a stroke of lightning (!). $2O = 3S$.

We may construct Na by $N + Aq = 23{\cdot}210$,—

$$Na : Cl = 1 : \sqrt[4]{8{\cdot}78} \text{ and } N : Na = 1 : 1{\cdot}65, \text{ the } (\sqrt[4]{8{\cdot}78}) \div \div 1{\cdot}049 \text{ (ref.)},$$

meaning a decomposition of Cl into Na and C,—

$$35{\cdot}470 - 23{\cdot}210 = 12{\cdot}260.$$

Tertiary disturbances produce complementary elements, for instance, bromine $= 78{\cdot}392$ about $3Na + O = 77{\cdot}943$; then iodine $= 126{\cdot}576$; $5Na + AqH = 126{\cdot}536$;—

$$N : Ka = Br : I = 1 : 1{\cdot}65 = 1 : 1{\cdot}72 \div 1{\cdot}049 \text{ (ref.)}.$$

* This reminds of Oken in his "Natural Philosophy." I do not remember the exact words: "the sea becomes salted by the action of the sun."

Ka = 39·257; Na + S = 23·210 + 16·114 = 39·318;
Na : Ka = 1 : 1·7. Complement barium = 68·663;
Ka : Ba = 1 : 1·75.

After the "metalloids" we get the "alkaline metals," and pass to the "earthy metals." I place silicon last, and prefer the old 22·221 to the modern 21·3.

The preceding elements increased in weight, as products of the union and new re-partition of primary elements during the contraction of a semi-nebular agglomeration of solids, liquids, and gases, of imperfect separation and stratification, and of great alternations of contractions, expansions, and temperatures. The "earthy metals" represent the transition from sea to land; the formation of more stable solids, by the reduction and decomposition of greater to smaller but denser atoms, requiring less pressure and less low temperature for solidity.

Mg : Al = Ca : Si, 12·676 : 13·720 = 20·515 : 22·211 :
: Mg : Ca = Al : Si = 1 : 1·75 ÷ 1·07 (*ref.*),
therefore Mg : Si = 1 : 1·75 = C : Na.

Iron, the dominant metallic metal, has under ordinary circumstances 2·83[3] times the density of *ice*, 1 : 2·83 being the surface of land to sea, and the density of water to land (*ref.*). It is a good conductor of heat and electricity: it is the magnetic element, with a decidedly polar arrangement of the atom or equivalent 2Fe.

The generation of iron might be satisfied by various combinations, for instance, by the condensation and mutation of 2Al = 27·464; but elementary generation is rather the re-distribution of matter in the abstract, not comparable to chemical combination. The earthy metals arose from the decomposition of the alkaline metals, with accession of the metalloids; the metallic metals produced by greater pressure and condensation under greater heat show, with a re-combination of preceding atoms, a re-increase of atomic weights. When we look on the Earth as having been first a galvanic cell, then a battery, an arrangement of many cells, gradually become a dynamo-machine with a condensed thoroughly ferruginous nucleus, separated by a frictional, heated, mutating stratum from the insulating prominently silicious shell, whose outside is wound round by ocean streams, conducting and propelling electricity, moving between the separating insulating continents they raised by lateral pressure and motion, all wrapt into the di-electric air, traversed by conducting vapour, we

form the proportion N : Cl = Si : 2Fe (the equivalency of Fe with its division into unequally constituted atoms),—

$$14{\cdot}188 : 35{\cdot}470 = 22{\cdot}221 : (27{\cdot}688 \times 2).$$

If the atom of Fe should have a characteristic in less or more (which I doubt, because the 0·688 is pretty near the 1÷40 of the 27)—(*ref.*), there is a group of complementary elements; atom Fe is then about equivalent to Cl − O. The density of liquid chlorine to solid iron is about $1{\cdot}33 \times 5{\cdot}7$; 5·7 is the density of the Earth, and a figure of mark for water (*ref.*).

S must prominently co-operate in the reduction of elements to Fe; therefore—

$$S : Fe = 16{\cdot}114 : 27{\cdot}688 = 1 : 1{\cdot}72$$

(manganese, 27·716; chromium, 28·191; cobalt, 29·568; nickel, 29·622; copper, 31·707; zinc, 32·311).—

S : Mn = 1 : 1·73, S : Cr = 1 : 1·75, S : Co = 1 : 1·83,
S : Ni = 1 : 1·84,

and overstepping the boundary—

S : Cu = 1 : 1·199, and S : Zn = 1 : 2·07, the $1{\cdot}72 \times 1{\cdot}15$ (*ref.*).

(Cadmium, 55·833; tin, 58·920; lead, 103·728).—

Zn : Cd = 1 : 1·72, Cu : Sn = 1 : 1·77, Zn : Sn = 1 : 1·8,
Sn : Pb = 1 : 1·75.

(Boron, 10·914 (about O+3H); fluorine, 18·734; phosphorus, 31·536). B : F = 1 : 1·7, F : P = 1 : 1·73.

Selenium, 39·631 (near Ka as Mg to C).—

$$Se : Ba = 1 : 1{\cdot}71, \text{ and } Ka : Ba = 1 : 1{\cdot}72.$$

Strontium, 43·854 to Ba only $\sqrt[4]{9{\cdot}013}$, to Br 1 : 1·78, but—(Arsenic, 75·330; antimony, 129·244). Sr : As = 1 : 1·72, As : Sb = 1 : 1·72.

Bismuth, if 71·070, to Sb 1 : 1·73, Bi and Sb standing quite opposed in the thermo-electric series. Others take Bi $71{\cdot}070 \times 3$.* Bi is almost always "native." It has no proportional respondent element, bringing it within the

* In "On the Atom and on Heat" I saw reasons to prefer this figure. I discussed at length the cause of the thermo-electric position of Bi and Sb, and the reasons why the elementary quality of Bi, and far more of Hg, might be doubted; or which might be, if they were elements, the causes of the distinctive features which seemed to separate them from the systemic elements, and which were the nature and characteristics of what might be called the transition or intermediate elements.

stricter limits of the development of the system. Is it all terrestrian? is it no element? When $Bi = 71{\cdot}070 \times 3$, or the equivalent *three* atoms, we get $2Fe : Bi = 1 : 3{\cdot}83$ as the non-conducting part to the surface of the Earth, &c.

Silver, 108·305, to gold, 199·208 = 1 : 1·83.

Palladium, 53·359, to platinum, 98·841 = 1 : 1·85, &c.

The "development theory" gives the origin of the relations 1 : 1·7, 1 : 1·72, 1 : 1·85, marking the extremes and means of solar distance in the motion of the two great planets, the motion of the system having its correspondence in the central mass, and their continuity in ascent and descent of proportions, of mutual disturbances within the whole system. The return of similar relations of atomic weights between kindred elements, and prominently between the dominant elements, is therefore significant for the metaphysics of elementary evolution.

I have not yet mentioned mercury—a rare, yet important, and in its qualities exceptional, element. The atom is 101·431, to which applies what was said of Bi. It is next above the suspected Bi in inferior electric and thermic conductivity. Hg : Cl = 101·473 : 35·470 = 2·83 : 1 as sea to land, or, inversely, the density as the conducting to the insulating surface of the Earth.

Like H, it has and has not characteristics of a real metal. The atomic weight of this poor conductor is $8{\cdot}013 - 1 = O - H$ less than that of the prominent conductor, silver. Hg is liquid at ordinary temperature, and dissolves most metals directly; when warmed, tin, lead, zinc, bismuthum, a group, the two latter evaporating with Hg in rectification. It easily dissolves gold and silver. For the extraction of silver from its ores, $NaCl_2$ is added to Hg; the metallic water moistening the ores is made ocean water; the proportion of weight in HgCl combining with Ag is—

Hg 74·09 : Cl 29·97 = 2·83 : 1,

the relation defined. The density of Ag at ordinary temperature is to that of solid Hg, at −40° C.,—

10·542 ; 14·391 = 1 : 1·33 = water to liquid chlorine.

The limits of liquidity are for Hg −40° C., for Ag near 1000° C., water at 0° being the standard limit, 40° to 966° = 1 : 24·16 (*ref.*).

The equivalency of iron, $2Fe : Hg = 1{\cdot}182$, as their density when both are solid. Their conductivity is Fe; Hg when both solid, 5·7 : 1; when Fe solid, Hg liquid, 6·7 : 1,—both characteristic figures for Aq (*ref.*).

Mercury freezes near −40° C., a characteristic temperature for vapour of water tension (*ref.*); it boils about 360° C.; its evaporation becomes perceptible beyond 32° C. The change of temperature between freezing and boiling of water is 100° C.; it is 400 for Hg, four times more; for ocean water 3·83 times more. Water expands by freezing, 1÷12·08 (polar zone of the hemisphere), and from 0° to 100° 1÷24·016, with greatest contraction at 4·13° C. (*ref.*). Mercury expands for each degree between 0° and 100°, the 1÷5550, towards −40° less, towards 360° more. Hg therefore expands, for equal change of heat, 2 to 1·95 less than water or ocean water, or $\sqrt{4}$ to $\sqrt{3·83}$ less. Hg expands from state to state 1÷12·08, the double of water.* The densities of Hg being 13·88 at 4° C., and 14·39° at −40° C., the density of solid Hg is $3·83^2 = 14·66$ that of water—diff. 1÷59·56 (*ref.*).

This shows a curious similarity and reciprocity between Aq and Hg. Is mercury a large atom combined with H?

In the original paper there were remarks about the making and unmaking of elements, and propositions for experiments with I, Br, Chl, and Hg; but being no experimentalist I had better abstain from such suggestions.

II. THE COMPOSITION OF SEWAGE.

By J. W. Slater.

STRANGE to say even professed sanitarians, municipal authorities, and the like, not to speak of educated and intelligent people in general, have often very vague notions concerning the nature of sewage. They know that it is nasty, and contains various matters unsightly and offensive. But they are little aware of its complexity and of its liability to vary, according to the locality, the season, and even the hour of the day. Were these points better

* Water expands 1÷12·08 when become ice; mercury contracts about 1÷12·08. Bi is said to expand when again become solid after liquidity at 265° C. (Marx), but this may be not quite true, as pointed out in "On the Atom."

understood many futile processes would never have been proposed, and if proposed would never have been entertained.

I will take first the simplest case, that of a "residential" town. By this term sanitarians mean a town where few, if any, manufacturing operations are carried on, and where the liquid refuse is chiefly of domestic origin. As examples may be mentioned Oxford, Bury St. Edmunds, Leamington, Keswick, &c. The sewage of such towns is generally of a concentrated character, and the matters which it holds in suspension and solution are for the most part of an organic and a readily putrescible character. It contains the solid and liquid excretions of the inhabitants, the urine of horses and cattle discharged in the streets, the drainage of stables, piggeries, &c., the blood (more or less) of the cattle killed in the town, and the washings of slaughter-houses. Another important constituent is the water which has been used for washing the persons of the inhabitants, their clothing, their cooking utensils, &c. These slops, as they are called, are very offensive; they hold in suspension and solution soap, fatty acids, the juices of meat and vegetables, and the exudations from the human skin. Almost everyone must have observed that if a bowl of suds from "washing day" has been allowed to stand, it gives off in a very few hours a most unpleasant odour. There are also certain organic substances not offensive, nor readily capable of putrefaction, but which nevertheless play a very important part as far as the treatment of sewage is concerned. Thus a very large quantity of waste paper finds its way into the sewers, and is there subdivided into particles which quite escape the notice of an inexperienced observer. To these are added fine filaments derived from washing linen and cotton articles, and to a less extent from woollens. I say to a less extent, not because woollens when washed give off a smaller quantity of fibre, but because the total amount of woollens washed in a residential town is much smaller than that of cotton and linen fabrics. These filaments of textile materials and of paper are scarcely perceptible on a hasty examination. A glass of sewage, held up to the light, if not rendered turbid by suspended clay, road-silt, &c., appears almost as limpid as ordinary river- or pond-water. But if we attempt to filter it through the filter-paper used by chemists we find that the flow, though tolerably rapid at first, is quickly retarded, and before long comes practically to an end. If the liquid is then carefully poured away from the filter-paper, and a small portion of the latter is examined

with the microscope, it will be found coated with the above-mentioned filaments of textile matters, which effectually choke up its pores. If we attempt to filter sewage through coke, asbestos, gravel, sand, peat, or ordinary arable soil, the same difficulty is encountered, the rapid flow observed at first becoming sooner or later obstructed. Hence, as I shall endeavour to explain more fully below, filtration is practically useless even for freeing sewage from its suspended impurities.

There is another constituent of sewage harmless in itself, but which seriously interferes with most processes of treatment. I mean the sand, gravel, and pulverised stone which are washed into the sewers by every heavy shower. I show elsewhere how this silt, &c., by keeping bad company, acquires offensive properties. Its inconvenience in every form of sewage treatment will be duly noticed.

In a manufacturing town or district the sewage is of a much more complicated character, and is more unsightly, though not more dangerous to public health. Nay, sometimes its purification is easier than that of the sewage of a purely residential town.

The pollution reaches its greatest height where the textile, tinctorial, and chemical arts are carried on. Here we find in the sewage, in addition to excrementitious matters, &c., sulphuric, hydrochloric, and nitric acids, alkalies, soap-lyes, solutions of iron, zinc, tin, alum, copper, chrome, antimony, and arsenic, waste dye-liquors and spent dye-wares, glue, sizes, waste tan-solutions, &c. It must not be supposed that all these substances will be found in the sewage of a manufacturing town at one and the same moment. Many of them, indeed, neutralise and precipitate each other,—a circumstance on which is founded a simple process for dealing with liquid industrial refuse. But if we watch the flow of such sewage we shall find striking changes both in its colour and its odour, according to the kind of filth just emitted by one or other manufacturing establishment. I have often seen some agent proposed for sewage-purification fulfil all requirements for hours in succession, but on the sudden discharge of a new kind of impurity into the sewer it has been found not merely useless, but even injurious, actually intensifying the evil.

The sewage of such towns, it may be observed, though containing a larger proportion of solid matter, both suspended and dissolved, than that of a residential town, is of far lower agricultural value—a point to be had in remembrance in selecting a method for its purification. Some of

its possible ingredients, indeed, such as proto-salts of iron (ferrous salts), alkaline sulphides, &c., are not merely useless to vegetation, but positively injurious.

The sewage of districts engaged in the metallurgical arts, the manufacture of hardware, &c., contains little extra organic impurity. On the other hand, it often holds in solution iron in considerable amount, derived, *e.g.*, from "pickling" iron wire. Copper and tin are rarely present, the value of their solutions being a guarantee that they will not be knowingly and wilfully run into the sewer. But the proto-salts of iron—*e.g.*, ferrous chloride, formerly known as muriate of iron, produced whenever metallic iron is scoured or cleaned from rust by means of hydrochloric acid (muriatic acid, spirit of salts)—is abundant in certain kinds of sewage, and is not merely hurtful to crops for the time being, but is a permanent steriliser of the soil.

The sketch of the sewage of manufacturing towns just given is of course very general. Each such town, in fact, turns out a special quality of sewage, the nature and effects of which can be understood only after careful experiment and observation.

Both in residential and in manufacturing towns there is generally a very marked difference between the day and the night sewage. In a residential town the sewage, from midnight to 5 or 6 in the morning, is very much reduced both in quantity and in strength. Often it consists of little more than the surface-water from the streets and roofs, &c., and of the ground-springs, which often find their way into the sewers to a considerable extent. As the day advances the flow of sewage becomes more abundant and more offensive, and is at its worst from 2 to 8 p.m., or thereabouts. In manufacturing towns the difference between the day and the night sewage is less marked, since certain kinds of waste waters are discharged in the night if requisite, and refuse which should not rightfully be run into the sewers at all is often introduced when there is the least chance of observation. Hence it is a serious mistake to imagine that the night sewage may be safely neglected, and allowed to pass into the water-courses without purification.

On Sundays in a residential town the sewage differs little, if at all, from its condition on the other six days of the week. In manufacturing towns it is on Sundays more purely excrementitious in its character, the industrial waste waters being in great part wanting. The same holds good with respect to public holidays. In small agricultural towns the sewage on market-day is very perceptibly stronger

than on other days, and requires an extra share of attention.

The question has often been raised whether there is any marked difference between the sewage of a "closetted" town and one where a part, larger or smaller, of the population make use of the old-fashioned cesspools, or of dry earth-closets and similar appliances. Certain authorities, on the faith of their analyses, have maintained that there is little or no difference in the strength of the sewage. Careful consideration will show that this is scarcely possible. It may be at once admitted that the liquid excrements of man, and of all analogous animals, contain a larger proportion of nitrogenous matter than do the solid excreta. But in a closetted town the whole of the excrements of the population, liquid and solid, find their way into the sewers, and thence into the river. In an unclosetted town not merely the solid, but a large part of the liquid excretions are discharged into the cesspools, dry closets, &c. Very frequently also, in small straggling towns, public urinals, if they exist at all, are not connected with the sewers. Thus the water running in the latter consists to a great extent of soapsuds, the washings of plates and dishes, and, in short, what is technically known as "slops." I do not see, therefore, how it is possible for the sewage of an unclosetted town, other things being equal, to be as rich in nitrogenous matter as that of a thoroughly closetted town.

A very important consideration is the water-supply, known and unknown. By the known supply I mean the average quantity per head of the population served out from the water-works. By the unknown I mean the quantity which leaks into the sewers from other sources. Where the sewerage system lies in a wet sub-soil, with many ground-springs, and where the sewers themselves are not water-tight, the flow of sewage in dry weather may rise to 100 gallons per head of the population per twenty-four hours, whilst in towns where the water-supply is scanty, or where the sewers are well made, it may fall as low as 20 gallons.

Another very important distinction is the space covered by a town in respect to its population. Where the streets are wide, where there are few persons to a house, and where there are many gardens, paddocks, vacant spots of building ground, &c., the sewage, especially in wet weather, is so much diluted that it loses all its distinguishing properties, and is little worse than ditch-water.

This brings us to the question of single or double

sewerage. It is suggested by many engineers that the water-closets, the domestic sinks, the public urinals, &c., should discharge their contents into one set of sewers, whilst the surface-drainage is carried away by a distinct system. It must be admitted that this double system has some decided advantages: the sewage, properly so called, would be at all times much more nearly alike in strength and quantity, which would facilitate its treatment, whether by irrigation, filtration, or precipitation. Its value would be also much greater. On the other hand, the expense of the double system is a very serious consideration. The water from the street-gutters, though receiving nothing from the urinals and closets, will be far from clean, and its admission into the streams will be very doubtful. In manufacturing towns there are many waste liquids,—*e.g.*, the rinsing-waters from dye-works,—which if run into the sewage will very much dilute it, but if allowed to pass into the rivers will greatly spoil their appearance.

Lastly, it is sometimes found, even where the ordinary single system prevails, that the sewers require flushing to prevent solid matter from being deposited in parts where the gradient is insufficient. It is reasonable to suppose that this will be much more frequently the case in a sewer which carries fæcal matters only, undiluted with surface water. Here, then, we should get back, occasionally at least, to that dilution of the sewage which was to be avoided by the double system.

III. THE PARASITES OF CIVILISATION.

LET no galled jade wince! We are not about to discuss the "social parasite"—the schizomycete in human guise, who, by a necessity of his pathogenic nature, seeks to split up faiths, societies, empires, into sects, cabals, and factions, just as his prototype splits up healthy cells and converts them into ptomaines. With such parasites we have no concern. Our object is to view the vegetable and the infra-human animal world in its relation to

civilisation,—not exclusively and necessarily to civilisation as now existing, but to any and every possible civilisation.

From this point of view, then, we may divide the organic world into several classes. First come those which have entered into human civilisation, and assumed a more or less important part in it, as domestic animals and cultivated plants. As such they minister to our necessities, our convenience, our pleasures, our follies, and our vices. But with this important class we have here nothing to do.

Again, there is a very numerous class of organisms which remain outside of human civilisation, and occupy a more or less independent position. Such organisms may be hostile to us, or neutral, or, even in the result of their life-work, friendly. They may be useful or useless from a human point of view; but they have these points in common, that they do not lend themselves to domestication or common cultivation, but retire from the face of man, and become less numerous in proportion as any country is more thickly settled and is brought under general cultivation. As examples we may mention the wolf, the bear, hyena, wild swine, wild ox, hostile to man and long ago extirpated in Britain; the stork, the roller, the golden oriole, harmless or even useful, and extirpated also; the goldfinch, kingfisher, "scarce swallow-tail" butterfly, and red underwing moth, all harmless, but becoming rarer from season to season, and, without some capital change in the habits of the public, doomed to certain extirpation.

With those animals and plants which we have named the parasites of civilisation—animal and vegetable—the case is utterly different. They are all hostile to man, doing him great injury either in his person or his possessions. But instead of receding from man, or of growing scarcer as he becomes more numerous, more powerful, and wealthier, they actually "grow with his growth and strengthen with his strength." This is, in fact, the reason why we term these beings "parasites on human civilisation" rather than simply "parasites on man." Not a few of them, as we may have to emphasize below, are nearly harmless to the wandering savage, but formidable to the dweller in cities or in highly cultivated plains.

A peculiarity of these parasites—weeds and vermin—is that civilised man, for the most part unwittingly, and we may feel sure unintentionally, introduces them into "new countries" when he goes to settle there, or introduces them to his home in the course of trade. In this manner the grey or Russian rat has been conveyed round the world.

In this manner numerous vile weeds have been introduced into Australia and California; the house-fly, the "cabbage white," and the Hessian fly into North America; the *Phylloxera* into France; the bed-bug and the cockroach into Europe generally; the chigoe into tropical Africa; and multitudes of other undesirable species have been imported into regions where they were formerly unknown, and where their room would be much more desirable than their company.

Cases have happened where parasitical animals have been introduced by man into new countries knowingly and wilfully, but from ignorance of or mistake as to their probable behaviour. Under this head may be mentioned the conveyance of the thistle to Australia, and of the European sparrow to the United States,—both unfortunate experiments, regretted by the public at large, if not by their ill-judging perpetrators.

If we cast a glance at the entire series of these parasites we find them, at least as far as animals are concerned, distinguished by a relatively small size. Hence they are able the more readily to conceal themselves from hostile search. Conjoined to small size, we find prodigious fecundity. Hence though the individual is feeble, the species is mighty. We may think them extirpated, but, if only a very few have escaped our pursuit, a short time sees them as numerous and as destructive as ever.

Another important feature in parasites, or at least in a very large proportion of them, is a nocturnal or—what amounts almost to the same thing—an underground life. Everyone will here be reminded at once of the mouse and the rat, the snail and slug, the bed-bug and cockroach, the mole-cricket, the larvæ of the cockchafer, the wireworm, the crane-fly, which work havoc beneath the soil,—not to speak of the *Phylloxera*, which attacks principally the roots of the vine. It needs little reflection to show how nocturnal and subterranean habits must withdraw any animal from ordinary human observation, and as a matter of course from attack.

Another feature, almost universal, is tenacity of life, and power of supporting great differences of climate, and other of the conditions of life. Without such tenacity, indeed, few plants could be weeds, and fewer animals could rank as vermin. For the latter, to be omnivorous is an important qualification. The rat and the mouse feed either upon vegetable or animal matter, whether living or dead. Almost all the slugs and snails will consume animal food, egg,

grease, and human excrement, as readily as plants, growing or decayed. The sparrow is omnivorous, though it greatly prefers grains, fruits, &c., to flies and larvæ. The house-fly is the very type of an omnivorous animal. It consumes all the varied substances which enter into the diet of man, and a few more. Our most rampant weeds are proverbially hardy. With many nothing will kill them save individual extraction from the soil and consumption by fire. But, in a clayey soil, to remove every fragment of the root of a wild convolvulus is almost an impossibility. We have been told by a labourer who had been employed in laying the sewers of a country town that the roots of this weed were traced down to a depth of eleven feet. The tenacity of the dock, the thistle, the buttercup, the dandelion, and the groundsel is well known, and few indeed are the fields, or even the gardens, which are completely freed from these enemies.

Perhaps we have here a consideration which may lead us to a definition—approximate at least—of vermin and weeds. There are, as we have already mentioned in passing, animals, such as the wolf and the lion, which, though hostile to man, undergo extirpation wherever civilisation is thoroughly established. Had France and Spain been for a couple of centuries occupied by the American people, it is safe to say that not a wolf would have survived down to this day. These animals, and many more that might be named, being extirpable and retreating before civilisation, cannot be called "vermin." In a similar manner there are many plants which we do not cherish and cultivate, and which have, indeed, nothing to recommend them, but against which we do not need to take any special precautions. Such plants, therefore, can scarcely be called "weeds."

It is interesting to compare, when opportunity offers, a plot of land which has never, as far as is known, been subjected to cultivation, with another plot of similar soil which has once been cultivated, but has subsequently been left to what we may curiously call "Nature." Between the respective floras of these two plots there is a wonderful difference. The originally untilled plot contains an average assortment of the wild plants of the district. The plot which has been deserted will be found, as a rule, stocked exclusively with the most characteristic "weeds,"—vegetable species which seem to be fostered by cultivation, unless it is of the most thorough-going and persistent character.

This brings us to another essential point: these parasites of civilisation, vermin and weeds, are notably ugly. Many

wild animals of the most different groups are exceedingly beautiful. But where is the beauty, from a human point of view, of the rat, the mouse, the cockroach, the bed-bug, the chigoe, the flea, the crane-fly, the wireworm, and the bulk of their associates? Perhaps the Colorado beetle is the only tolerably looking animal species which is at once hostile to man and increases at the approach of cultivation.

With the plants parasitic upon human civilisation the case is very similar. Name our chief weeds, as distinct from wild plants, and you name those which have the least claims to beauty. Their flowers, if sufficiently conspicuous to be called "flowers" in the popular sense of the term,* are for the most part yellow. Now at the risk of being called Philistines by the Æsthetic School, we must mention that yellow flowers must be assigned to the lowest rank. Nature seems to produce them with the greatest ease, just as the British workman turns out jerry-work, without special effort or attention. A weed with a large conspicuous blue, purple, or crimson flower would be something out of the common track.

In this connection we come upon the curious fact that no true weed—no plant which thrives all the more luxuriantly for the labours of the husbandman and the gardener—gives off fragrance, either from its flowers or its leaves. Many of them, on the contrary, are decidedly offensive, or at the best scentless.

Another noteworthy circumstance is that so many of our worst plant-parasites on civilisation belong to the order of Compositæ, to which some botanists assign the highest rank in the vegetable world; plants which flourish as being eminently adapted to present conditions, and are consequently—success being now the received test of merit—entitled to pre-eminence. They may be considered as in some sort analogous to the financiers and usurers who, under the star of Judas Iscariot, thrive best among us men of the nineteenth century.

It is singular, and not by any means cheering, that the exceptional power of multiplication, and the tenacity which we have noted in vermin and weeds, should be so singularly connected with inutility and even positive harmfulness to man,—with ugliness, as shown in the absence of brilliance and perfume, and with mean or insignificant forms. So

* Surely we want here a word, or a pair of words, to distinguish flowers which have a conspicuous corolla, calyx, or both, from flowers in which these parts are wanting, or are so slightly developed as to escape the notice of the general public.

sure as an animated being pleases us with its beauty, solaces us with its song, and leaves our persons and property uninjured, so surely we find it comparatively rare, decreasing in numbers, and hovering on the very verge of extinction. So sure as a wild plant is pleasing to us by its form, its colours, and its fragrance, its preservation seems to task all our efforts. A beautiful or a harmless animal or plant never, we believe, becomes naturalised in any country by accident. With the ugly and the noxious animal and plant the converse holds good. The utmost we can effect against such of these as come under the category of the parasites of civilisation is to keep them at bay, to prevent their increase. How we have to watch against the immigration of new vermin and weeds, and how often do they elude our vigilance!

Why this disconnection between beauty and utility, on the one hand, and vitality and fecundity on the other, should exist is an unsolved problem. Many attempts at an explanation have been made, but none of them have proved acceptable save within very narrow limits.

Some say that we consider beautiful chiefly what is rare, and loathe, or at least ignore, whatsoever is common. This suggestion by no means holds good. There are many districts where, *e.g.*, the mountain- and the cross-leaved heaths (*Erica cinerea* and *E. tetralix*), harebell, the wild wood-hyacinth, the forget-me-not, are as abundant as are in others the veriest weeds. Yet no man fails on that account to recognise their beauty. On the contrary, they seem far more attractive in masses than when scattered singly. So the question of rarity or abundance is not to the purpose.

Another explanation advanced is that certain animals and plants are extirpated on account of their very beauty, whilst the ugly are passed by. In this there is unfortunately a certain amount of truth. The shady coombes of Devon are being plundered of their delicate ferns, and the woodlands of Kent and Suffolk stripped of their lilies of the valley, by dealers and their emissaries. We know not a few localities where choice wild plants have flourished within a few years, of which now not a trace remains. We fully admit that any rare and beautiful bird showing itself in this country is at once shot down, to be exhibited as a "British specimen" of so and so. We know, and had we the power we would visit with crushing penalties, the destruction of humming-birds, trogons, birds of paradise, &c., at the dictates of fashion and ostentation. But all this does not

go to the real root of the difficulty. Every farmer and every gardener wages against weeds a war far more general and systematic than that carried on by dealers against the oak-fern, the beech-fern, or the lily of the valley. Yet the weeds survive in the face of this crusade, whilst the beautiful plants do not.

One point, indeed, must be remembered, *viz.*, that our lovely wild flowers and ferns are limited in their choice of localities. The devastation of our woodlands deprives them, in many cases, of the only spots they can inhabit, whilst the weeds can accommodate themselves to changes of soil and exposure. But this is no explanation; it is merely a restatement of the question. We have still to ask *why* our beautiful wild plants have, as compared with weeds, so little tenacity and adaptability?

In comparing beautiful birds or insects with vermin, we meet the very same difficulty. The sparrow can outlast an amount of slaughter or capture, far more than enough to sweep away the nightingale, the goldfinch, or the kingfisher not merely from Britain, but from the entire earth. The hawk-moths and red underwings are perishing beneath the attacks of collectors; but the cabbage-whites, the cabbage-moth, and the magpie-moth seem little affected by the wholesale slaughter of their larvæ which are carefully picked off the cabbage-plants, turnips, gooseberry- and currant-trees, wherever seen, besides being treated with appropriate poisons.

A more sensible answer has been given by an American writer, which, as far as it goes, may be fully accepted. He contends that our choice flowers, fruits, and vegetables are absolutely artificial productions, out of harmony with the natural flora and fauna of the district where they grow, and can be preserved only by a maintenance of the artificial conditions under which they have originated. The *raison d'être* of the cultivated fruit or flower is man's convenience, advantage, or gratification. It has been modified by him to that end without reference to its power of succeeding in the struggle for existence.

Further, cultivation presents a number of plants in vast masses together. This is a demand which creates a supply of enemies. Just as for a conflagration we must collect together a large quantity of combustible matter, and as for an epidemic we must have a dense population, so for the recent development of the Colorado beetle we must have potato-fields, and for the ravages of the *Phylloxera* we must have extended vineyards.

But this consideration meets a part only of the difficulty. The question still arises, why, among natural species of plants and animals, totally unmodified by man, we find the same difference,—the ugly, the useless, and the pernicious being more prolific and more tenacious of life than the useful and the beautiful?

We must therefore hazard the suggestion that the attainment of what strikes us in beauty, whether in form and colour, or in sounds emitted and fragrance given off, must in reality be an exhaustive strain upon the resources of either animal or plant. If this is the case the organic world is not developing in the direction of beauty, and the ugly shall inherit the earth.

In concluding we must raise the question, In which of the divisions of the animal and vegetable worlds are the parasites upon civilisation mainly to be traced? Among mammals there are few, all rodents,—the mouse, the rat, and some allied species. The squirrels are certainly enemies of man, as attacking and injuring not a few of his cherished possessions, and destroying harmless and beautiful wild birds. But they recede before increasing population, and find no shelter in our cities, so that they cannot rank among the parasites. One of the worst features of the parasitic rodents is that they furnish a pretext, at least, if not an actual necessity, for the cat and the terrier,—two most objectionable animals, the dread of all who love flowers and birds.

Among birds we can name only one truly parasitic species —the house-sparrow. This bird has not a single redeeming feature, and has beyond doubt multiplied, *pari passu*, with the development and the spread of civilisation. His worst feature, next to the unfortunately successful war which he wages against the martin and swallow, is that we can scarcely extirpate him without scaring away useful and harmless birds.

Of reptiles, amphibia, and fishes, none, from their very nature, can rank as parasites upon civilisation.

The invertebrate parasites space will not allow us to discuss in detail. Among mollusks are the terrestrial snails and slugs, and among insects a very considerable number.

IV. ON THE SPONTANEOUSLY REVERSIBLE SPECTRAL RAYS,

AND ON THE

ANALOGY BETWEEN THEIR LAWS OF DISTRIBUTION AND INTENSITY, WITH THOSE OF THE RAYS OF HYDROGEN.

(Concluded from page 352.)

Particular Arrangement of the Spontaneously Reversible Groups.

WHEN we examine, in different photographic proofs, the groups of rays which are reproduced periodically with an especial regularity, we find most frequently that these groups belong precisely to the category of the spontaneously reversible rays, for some of them are reversed and the others are on the point of being so: for one and the same metal the reversals are more or less complete according to the conditions of the experiment, and for different metals according to the chemical and physical properties of the metal. Further, the law of the distribution of these groups presents another character common relatively to the succession of distances and of intensities: the rays become more and more close together towards the more refrangible side, decreasing at the same time in intensity. This feature is the more striking as the number of reversed rays is more considerable, and as the field upon which they are detached is more uniform. It seems as if, with the rise of temperature, the spectrum tends towards a final aspect,—that of a continuous brilliant ground, devoid of every ray other than the regular series of the spontaneously reversible rays. It is to this constitution, which is to some extent ultimate, that M. Cornu wishes to draw the attention of observers.

The number of metallic spectra which can give a regular series of spontaneously reversible rays is very considerable; but the first series hitherto observed are furnished by two metals which, from a chemical point of view, we should not

expect to find side by side. These are aluminium and thallium, whose atomic weights figure about the extremities of the list of elementary bodies.

Analogy with the Distribution of the Rays of Hydrogen.

M. Cornu does not stop to indicate the fruitless attempts at numerical calculations which he undertook with the view of representing each of these series by the substitution of the series of whole numbers in a simple function. He had abandoned these researches when the beautiful discovery of Dr. Huggins on the spectra of the white stars brought back his attention to the subject, and opened up to him a new horizon. These spectra present a common series of dark rays,—that is to say, reversed rays,—fulfilling precisely the conditions of distance and intensity which characterise the spontaneously reversible rays in the metallic spectra. This series prolongs the series of the well-known rays of hydrogen, C, F, G′, *h*; we might then foresee that the entire series would participate in it. This has been since confirmed by the researches of Vogel, though still leaving some uncertainty. The interest of this identification was such that M. Cornu undertook to verify it himself, which he has only just effected. The experiment is not free from difficulty, but by taking more and more minute proportions to remove the impurities of the rarefied hydrogen gas he has seen the foreign rays successively disappear, and he has finally succeeded in obtaining photographic proofs offering the series of astral rays in all their purity.

The following proposition summarises the result of these researches:—

> "In the metallic spectra certain series of spontaneously reversible rays present the same laws of distribution and intensity as those of hydrogen."

V. MR. A. R. WALLACE, F.R.S., ON THE RELATIONS BETWEEN SPIRITUALISM AND SCIENCE.

By R. M. N.

IT is no longer possible to ignore the phenomena known collectively under the name of Spiritualism. Unwelcome as these facts may be to many of us, serious as are the conclusions to which they seem to lead, there is nothing to be gained—and possibly there may be much to be lost—by persisting in an attitude of blank sweeping denial. At all events let us know the worst. If the new revelations, as it seems to me,

> "Cast on all things surest, brightest, best,
> Doubt, insecurity, astonishment,"

we must still seek what basis, if any, is left for law and order. It is therefore that I took up with eagerness Mr. Wallace's paper ("Light") which I am about to examine. Surely, I thought, he, more than perhaps any living man, will be able to show a harmony between Science and Spiritualism.

My hopes have been but very partially fulfilled. To me Mr. Wallace seems to pass over the points which underlie the repugnance with which men of Science regard Spiritualism and its advocates. Mr. Wallace writes:—

"It is a common, but I believe a mistaken, notion, that the conclusions of Science are antagonistic to the alleged phenomena of modern Spiritualism. The majority of our teachers and students of Science are, no doubt, antagonistic, but their opinions and prejudices are not Science. Every discoverer who has promulgated new and startling truths, even in the domain of Physics, has been denounced or ignored by those who represented the Science of the day, as witness the long line of great teachers from Galileo in the dark ages to Boucher de Perthes in our own times. But the opponents of Spiritualism have the additional advantage of being able to brand the new belief as a degrading superstition, and to accuse those who accept its facts and its teachings of being the victims of delusion or imposture,—

of being, in fact, either half-insane enthusiasts or credulous fools. Such denunciations, however, affect us little. The fact that Spiritualism has firmly established itself in our sceptical and materialistic age, that it has continuously grown and developed for nearly forty years, that by mere weight of evidence, and in spite of the most powerful prepossessions, it has compelled recognition by an ever-increasing body of men in all classes of society, and has gained adherents in the highest ranks of science and philosophy, and finally that, despite abuse and misrepresentation, the folly of enthusiasts, and the knavery of impostors, it has rarely failed to convince those who have made a thorough and painstaking investigation, and has never lost a convert thus made; all this affords a conclusive answer to the objections so commonly urged against it. Let us, then, simply ignore the scorn and incredulity of those who really know nothing of the matter, and consider, briefly, what are the actual relations of Science and Spiritualism, and to what extent the latter supplements and illumines the former.

"Science may be defined as knowledge of the universe in which we live,—full and systematised knowledge leading to the discovery of laws and the comprehension of causes. The true student of Science neglects nothing and despises nothing that may widen and deepen his knowledge of Nature, and if he is wise as well as learned he will hesitate before he applies the term 'impossible' to any facts which are widely believed and have been repeatedly observed by men as intelligent and honest as himself. Now, modern Spiritualism rests solely on the observation and comparison of facts in a domain of Nature which has been hitherto little explored, and it is a contradiction in terms to say that such an investigation is opposed to Science. Equally absurd is the allegation that some of the phenomena of Spiritualism 'contradict the laws of Nature,' since there is no law of Nature yet known to us but may be apparently contravened by the action of more recondite laws or forces. Spiritualists observe facts and record experiments, and then construct hypotheses which will best explain and co-ordinate the facts, and in so doing they are pursuing a truly scientific course. They have now collected an enormous body of observations tested and verified in every possible way, and they have determined many of the conditions necessary for the production of the phenomena. They have also arrived at certain general conclusions as to the causes of these phenomena, and they simply refuse to recognise the

competence of those who have no acquaintance whatever with the facts to determine the value or correctness of those conclusions."

I must now proceed to examine these contentions. That, like any utterances of Mr. A. R. Wallace, they merit a careful—and even a deferential—consideration it does not need to be urged.

The fundamental initial difficulty which Mr. Wallace, so far as I can see, does not attempt to remove is this:—Science is based upon what we, for want of a better name, term *law*. Spiritualism rests upon *will*. Science—and not merely our present science, but any possible science, so far as I can conceive it—takes its stand upon the causal nexus, upon the regular sequence of cause and effect. Iron always sinks in mercury, and always dissolves in hydrochloric acid; oils and fats, if heated to a sufficient temperature, always burn. No matter in what age, in what corner of the world, or in what climate the experiment is made the result comes out the same. Hence we are able to foretell phenomena. We know that under the same conditions the same results will follow. There are, of course, numbers of cases in which the causes and conditions of phenomena have not been traced out. Here prediction is impossible; but we were gradually going on solving these difficulties, and meantime the power of prevision was recognised as the great distinguishing mark between Science—*i.e.*, organised knowledge—and mere desultory empirical knowledge.

Not only Science, but practical Art, all the doings of daily life, rest upon this same observed invariability. There is, in short, as we have always imagined, law and order in the universe.

Now *will*—finite will at least—is, I submit, the very antithesis of law. Where will—*arbitrium*—comes in, we have of necessity the *arbitrary*. The most of us, indeed ("humbugs" as we might be called for our pains by "advanced thinkers"), have all along recognised one infinite unvarying Will as the ultimate cause of all phenomena. But such Will, being unchangeable and entering at all times equally into all phenomena, occasioned no difficulty. Nor has it been possible to deny that the wills of men and the lower animals—I do not feel certain whether it is safe to add "and of plants also"—were capable of interfering to a limited extent and in certain directions with the order of Nature. But, according to what was considered established in the earlier half of the present century, men and animals

could act upon anything outside themselves only where they were personally present, or where there was material physical connection between the agent and the object acted upon. The limits, too, of human or other animal power were supposed to be approximately known.

With the advent of Spiritualism all this beautiful simplicity has been swept away. If Spiritualists are not mistaken there are around us numbers of finite invisible beings, of unknown powers and of unknown intentions, capable of interfering with the order of Nature. They can raise bodies in the air against the force of gravitation. They can kindle fires at pleasure, or deprive fire of the power of destroying organised beings or of occasioning pain. They can hurl stones, break furniture to fragments, convey living persons from a distance, even through walls; they can kill human beings without any visible agency. To me it seems that if these contentions are true, if there exist beings around us capable of exerting such powers, there are introduced, so to speak, into every equation a number of unknown quantities, rendering it for ever insoluble. We can only say "such results will follow under such conditions, if no spirits think proper to interfere." It seems to me that before any harmony can be shown between Spiritualism and Science it must be ascertained what are the limits of the powers of these "spirits," and under what conditions can they be exerted? In that manner only can a basis for Science be saved. If no limits to interference exist, or if none can be traced, then yesterday's experience or observation is no guide for to-day or to-morrow. We are, in short, put to intellectual shame and confusion.

This question has its moral aspect. It will be remembered how Oersted congratulates the modern world on its deliverance from the bondage of the Middle Ages, from the ever-haunting dread of the interference of spirits. He shows how unfavourable was the ethical influence of this system of belief, and how it repressed mental development. He was, it seems, premature: if the "mediums" of the present are merely the witches and sorcerers of the past, and if the "controls" are a modern form of familiar spirits, we are again returning to a "betooverte Wereld"—to a world dominated and overshadowed by the "supernatural." I submit, with all deference, that the refutation of Materialism and Agnosticism is too dear at such a price.

To harmonise Science with Spiritualism it will then be, in the first place, necessary to discover the limits of the power of spirits, under what conditions it is exerted,

and how it may be combatted when and where it is undesirable.

The second difficulty is what is inaccurately called the "passage of matter through matter." What is meant is the passage of one solid through another solid without the permanent disintegration of either. Phenomena of this kind are described as happening from time to time at Spiritualist *séances*, the case of the iron ring round a man's wrist being the latest and best known. We fear that many persons who repeat this incident scarcely realise all that it involves. The temporary disintegration, either of a human hand or of an iron ring,—in the former case without loss of blood, without pain, or even consciousness,—followed by the replacement of every molecule as it was before, is a miracle probably surpassing anything recorded in ancient traditions. Had I seen it done I do not hesitate to say that I should have considered that I was suffering from madness, and that in this state I saw what had no objective existence.

We next come to a much more difficult point. It has always been considered that the creation or destruction of energy is, if possible at all, the prerogative of one only Being. But, unless I fail to understand Spiritualist teachings, the "spirits" seem to have the creation of energy in their power. Suppose that a heavy weight is raised up by human instrumentality: if men push it up from below or lift it from above, with the aid of screw-jacks, pulleys, or the like, the motive power is derived from the consumption of certain forms of matter in the bodies of the men who work the machinery, and these forms of matter are again traceable to the heat and light of the sun. Or, if a steam-engine supplies the motive power, we find the source of such power stored up in the coal, and being again merely a result of the sun's action. We have been accustomed to say that no energy can be exerted except at the cost of the transformation of some kind of matter.

But what matter is transformed or converted, in order to yield the energy which is brought into play, when a "spirit" —*i. e.*, an unextended being—raises a massive dining-table up to the ceiling or pulls away the chair from underneath a man? By what agency is the conversion effected? If the ordinary axiom still hold good, that action and reaction are equal and opposite, where is the fulcrum or the point from which the force is exerted? These are questions to which scientific men, "students or teachers," will naturally seek for precise answers before they can accept the Spiritualist theories. They will seek to know whether—and, if so,

in what manner—the doctrine of the conservation of energy can be saved or not, and if not, what then? That this last question touches practice no less than theory does not need to be demonstrated. To establish a harmony between Spiritualism and Science it will be necessary, I submit, to show the origin of the energy which is at the disposal of spirits.

I do not see clearly whether or no Spiritualists claim the creation of matter as one of the prerogatives of spirits, and hence on this point I can say nothing.

The great fundamental law of Evolution is accepted by Mr. Wallace in the paper before me, and indeed nothing else could be supposed. Possibly—though I speak with great diffidence—the biologist may find fewer and slighter difficulties in accepting the teachings of Spiritualism than do the physicist and the chemist.

I have still to ask how the principle of continuity fares at the hands of Spiritualism? It seems to me that between man and spirits, of whatever grade, there is a gap not bridged over. The difficulty is greatest if we admit with the Occultists (?), and I believe with some of the Spiritualists, that there exist spirits inferior to man. Whether these are the disembodied spirits of some of the lower animals it does not appear, though I may remark that—both in "Light" and in the "Psychological Review"—I have met with cases of the reappearance of certain domestic animals. For the return of these beings to earth-life the evidence seems of the same kind as that in case of departed human beings.

Mr. Wallace continues:—

"We who have satisfied ourselves of the reality of the phenomena of modern Spiritualism, in all their wide-reaching extent and endless variety, are enabled to look upon the records of the past with new interest and fuller appreciation. It is surely something to be relieved from the necessity of classing Socrates and St. Augustine, Luther and Swedenborg, as the credulous victims of delusion or imposture. The so-called miracles and supernatural events which pervade the sacred books and historical records of all nations find their place among natural phenomena, and need no longer be laboriously explained away. The witch-craft mania of Europe and America affords the materials for an important study, since we are now able to detect the basis of fact on which it rested, and to separate from it the Satanic interpretation which invested it with horror, and appeared

to justify the cruel punishments by which it was attempted to be suppressed. Local folk-lore and superstitions acquire a living interest, since they are often based on phenomena which we can reproduce under proper conditions, and the same may be said of much of the sorcery and magic of the Middle Ages. In these and many other ways history and anthropology are illuminated by Spiritualism.

"Science will equally benefit, since it will have opened to it a new domain of surpassing interest. Just as there is behind the visible world of Nature an 'unseen universe' of forces, the study of which continually opens up fresh worlds of knowledge often intimately connected with the true comprehension of the most familiar phenomena of Nature, so the world of mind will be illuminated by the new facts and principles which the study of Spiritualism makes known to us. Modern science utterly fails to realise the nature of mind or to account for its presence in the universe, except by the mere verbal and unthinkable dogma that it is 'the product of organisation.' Spiritualism, on the other hand, recognises in mind the cause of organisation, and perhaps even of matter itself, and it has added greatly to our knowledge of man's nature by demonstrating the existence of individual minds indistinguishable from those of human beings, yet separate from any human body. It has made us acquainted with forms of matter of which materialistic science has no cognisance, and with an ethereal chemistry whose transformations are far more marvellous than any of those with which Science deals. It thus gives us proof that there are possibilities of organised existence beyond those of the material world, and in so doing removes the greatest stumbling-block in the way of belief in a future state of existence—the possibility so often felt by the student of material science of separating the conscious mind from its partnership with the brain and nervous system.

"On the spiritual [Spiritualist] theory man consists essentially of a spiritual nature and mind intimately associated with a spiritual body or soul, both of which are developed in and by means of a material organism. Thus the whole *raison d'être* of the material universe—with all its marvellous changes and adaptations, the infinite complexity of matter and of the ethereal forces which pervade and vivify it, the vast wealth of Nature in the animal and vegetable kingdoms—is to serve the grand purpose of developing human spirits in human bodies."

This last passage calls for a few remarks. My estimate

of the visions of Swedenborg is founded on the fact that whilst he could furnish descriptions of planets known in his time, such as Jupiter or Saturn, he gives no hint of the existence of Uranus and Neptune, which were then unknown to astronomers. Had he done so his visions would have been completely freed from the stain of delusion or imposture.

Upon witchcraft Spiritualism has thrown a new and unexpected light. If it was, as was generally held in the first half of this century, a mere delusion, then the punishments by which it was suppressed were gratuitous atrocities; but if the witches had really the powers attributed to them in the fifteenth, sixteenth, and seventeenth centuries,—if they could really blight corn, afflict man and beast with disease, pestilence, and death, or if they served as "mediums" for malignant spirits,—then their extirpation was not merely a duty, but a necessity, though the painful task unfortunately was carried out with needless cruelty.

VI. THE HEREDITARY TRANSMISSION OF STATURE TO FEMALE DESCENDANTS IN HORSES, AND THE FACTORS WHICH DETERMINE SEX.

DRS. SCHLECHTER and DÜSING have made certain interesting observations on these subjects, which are recorded in "Koch's Revue für Thierheilkunde," in the "Deutsch. Zeitschrift für Thiermedicin," and in the "Jena Zeitschrift für Naturwissenschaft."

The following are their principal conclusions:—

1. The average size of female progeny in horses—without reference to the crossing of different races—approximates more to the average stature of the mother than to that of the father.
2. Even abstracting from an average heredity of size, the stature of the female offspring is, in individual cases, nearer that of the mother than that of the father.

3. In those cases in which the stature of the father far exceeds that of the mother, the female descendants will be larger than the mother, but smaller if the father is only little larger than the mother, of equal size, or smaller.
4. The mean size of the female offspring of two parents of equal stature, whether of the same race or of different races, is generally a little smaller than that of the parents. The reason is that in those cases in which the female offspring exceeds the stature of of its parents, the difference is smaller than when it falls below them. The number of cases, however, in which the female descendant respectively surpasses or falls short of the stature of the parents is approximately equal.
5. When the size of female descendants is determined by the father, this happens most commonly in crossings in which the father belongs to the English blood or half-blood race. In all other races which have come under our observations no especial influence is perceptible, but it is perfectly indifferent to which race the father or the mother belongs.
6. In crossing English blood stallions with Arabian mares the female offspring produced almost exclusively exceeds the mean stature of the parents. On crossing the same stallions with Norman mares the reverse is the case.
7. In all the above-mentioned points exceptions are not rare, so that no simple rule can be given for predicting the stature of female posterity in horses.

As regards the factors which determine sex, Düsing lays down the following conclusions :—

Fiquet had observed in cattle the fact that animals whose sexual powers are called into more frequent requisition produce more individuals of their own sex. Düsing ascribes this result to the circumstance that in males in such cases the semen secreted comes quickly into requisition, and fecundation is therefore effected by means of relatively young spermatozoa.

Hence more male young are produced, whilst a sexually inactive male begets more female young, on account of the greater age of the spermatozoa. It follows that the greater the want of individuals of one sex, the greater demand is made upon those already existing, the more rapidly their sexual products are used up, and the more individuals of the

same sex are produced, thus restoring the balance. Want of nutriment has the same effect as sexual overwork. Weak bulls with powerful cows produce chiefly bull-calves; weak cows with strong bulls drop more cow-calves.

As for age, each individual at the time of its greatest sexual capacity is *least* disposed to impart its own sex to its descendants. In the human species the excess of boys is therefore greatest when the husband is considerably older than the wife. Düsing is therefore of opinion that animals have acquired the power of adaptation to produce more individuals of the sex which is in a temporary minority.

When food is present in abundance more females are born; in times of scarcity more males, because the chief burden of reproduction devolves upon the female.

Düsing draws the following conclusions from observations on the lower animals: the sexual proportion is self-regulating. That sex is produced more abundantly whose increase is at the time being the more advantageous for the preservation of the species. Such conclusions are not to be accepted without caution.

VII. TESTING FOR COLOUR-BLINDNESS IN THE MERCANTILE MARINE.

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IN a former paper, "Homer Colour-blind," I very slightly touched upon the wider question,—one which possesses interest for most people,—colour-blindness, as affecting mankind in general and the mercantile marine in particular. Although the investigation of this remarkable phenomenon brought to light a curious fact, that on an average one male out of every twenty-five is quite unable to discriminate the principal colours of the spectrum, it excited no great deal of attention until it became apparent that, both on our iron-roadways and on the ocean, deplorable accidents were likely to—and often did—occur, from the

colour-blindness of drivers and guards of railway trains, and of masters and pilots in charge of ships. It was at length fairly demonstrated that a certain percentage of persons employed on the railways, and in the Mercantile Marine Service, were, without being aware of it, unable to discriminate between the red and green signal colours in common use. Those who now offer themselves for employment on railways are, and have been for some years, subjected to a compulsory examination in colours, so that there no longer need be fear on this account. But as to the Mercantile Marine, the evidence adduced before the Royal Commission on Shipping, now sitting, shows that the loss of life and property at sea has in no way diminished, has in truth materially increased, during the last ten years, out of all proportion to the increase of shipping, and it is alleged that a number of the collisions that annually occur is due to the colour-blindness of the navigating officer or the pilot in charge.

The Board of Trade, eight years ago, came to the decision—because of the serious consequences involved in the question of colour-blindness—that all masters and mates should undergo a test-examination in the following colours, *viz.*, red, green, blue, yellow, black, and white, before proceeding to an examination for a certificate of a higher grade. During the first two years, between May, 1877 and 1879, no less than 39 candidates failed to obtain certificates on account of their defective colour-sense. From this number twelve should be deducted, who were subsequently reported to have satisfied the examiners on a re-examination, leaving the actual number of failures from colour-blindness at 26.

After 1880 the result of failure to pass the colour-test was made equivalent to that of failure to pass the ordinary examination in navigation and seamanship,—that is, it prevented a considerable number of candidates from obtaining the certificates for which they applied.

The value of the colour-test soon became manifest to those in authority, and thereupon the Board of Trade, in February, 1880, after bringing their views to the attention of the Local Marine Boards, and receiving the concurrence of the majority of those Boards, resolved to extend the colour-test examination to all about to serve in the Mercantile Marine, and make it compulsory upon masters and mates to submit to the test. Consequently since March, 1880, all officers who for the first time applied for certificates of competency, in any grade, have been subjected to a colour-test examination, and if they failed in this they were

not permitted to present themselves for the further examinations in navigation and in seamanship. In the event, however, of either a mate or master having already received a certificate of a lower grade, and presenting himself for one of a higher grade, and then failing to satisfy the examiner of his ability to distinguish colours, the higher grade certificate has been granted, with a statement written across it that "the holder has failed to pass the examination in colours." This has, no doubt, in individual cases operated prejudicially; it has prevented incompetent mates or masters from obtaining employment, but it is only right and just that shipowners should be in a position to protect themselves. No case of hardship has, however, come to the knowledge of the Board: furthermore, to guard against injustice or a hasty judgment on the part of the examiner, a candidate may, on the expiration of three months from his first examination, apply to be re-examined for a second and third time, and by a later order he can obtain the permission of the Board of Trade to be again tested in colours for the fourth and last time.

By the extension of the colour-test to all persons, any man or boy about to enter the Mercantile Marine can satisfy himself and his friends of his ability to distinguish the colours of the flags and lights in use on board ship. These optional examinations have also been the means of preventing those who are unable to name colours from taking to the sea at all as a means of livelihood.

It is a matter of considerable regret that the colour-test has not been made obligatory upon pilots and men on the "look out," as well as upon masters and mates. Pilots claim the right to navigate all ships as soon as they near our coasts, and it is of the very gravest importance that they should make no mistake as to the lights displayed by other ships. This omission is entirely owing to a divided authority, the pilot service being exclusively under the control of the Trinity House, a body alleged to be somewhat addicted to placing obstacles in the way of scientific progress.

The mode of conducting the colour-test examination is of a threefold nature—by coloured cards, wools, and glasses. The examiners are supplied with selected boxes of each of these, and the examination commences with the cards, the most important daylight test being red, green, and black: if the candidate is able to distinguish and name the colour of each it is sufficient, and he obtains his certificate. The standard red and green glasses are of the same colours as the "port"

and "starboard" lights of a ship, and these are used in a darkened room, a lamp being placed behind them. The testing by coloured glasses follows that of cards or skeins of wool, special attention being paid to the candidate's ability to distinguish the red from the green glass. The examination on the whole is made with a view of determining whether a candidate can distinguish signals by day,—as flags, which are composed of many colours,—and next whether he can distinguish signals by night,—the lamps carried by ships, which are either red, green, or white. If, therefore, a man can distinguish red from green, and both from white or black, the examiner considers that he will be able to follow the International Rules for the prevention of collisions at sea. This method of testing has, we are told, been found sufficient for the purpose for which it is applied, "that purpose being not to discover and record the peculiarities of sight of the applicant, nor his powers of detecting and arranging all colours and tints, but to test his ability to name a common well-known colour when it is placed before him."

Candidates can hardly be expected to complain of the easy-going method sanctioned by the Board of Trade. Nevertheless it will occur to members of the medical profession that it is capable of a good deal of improvement. First, to be thoroughly effective the examination should undoubtedly be made more practical,—that is, quite in accord with the conditions under which the recognition of coloured signals at sea will usually take place. Second, the examiners should, for obvious reasons, be trained men, well acquainted with the subject, and not retired ship-captains. With examinations more intelligently conducted than at present, it could hardly happen that so large a proportion of the candidates who on their first examination called green red, and red green, would upon re-examination obtain certificates.

The Board of Trade, however, with every desire to do its best, in 1881 endeavoured to ascertain the practice adopted by other nations, and a circular was issued to the principal powers of Europe, as well as to America. From the answers we gather that a colour-test has been in use in the United States for some years. In the case of pilots applying for the renewal of their licenses, or of applicants for original licenses as pilots on steam-vessels, examination is compulsory, and since 1880 a voluntary examination for all persons serving in the Mercantile Marine, as to physical fitness and ability to distinguish colour, has existed.

In the voluntary examination, the system known as "Holmgren's worsted test" is used; and the medical specialists who conduct them say that it has proved fairly satisfactory. With regard to European countries, Austria and the Netherlands are the only nations that have introduced a colour-test examination into their mercantile marine services, while France and four other nations have introduced a colour-test into their naval schools and State navies only. Belgium has instituted a compulsory examination for *employés* in mail-boats running between Dover and Ostend. Holmgren's method is used, and, in addition, all Antwerp pilots are examined by two ships' lights, red and green, presented at 10 metres distance from the candidate; the position of the lights being changed rapidly. Flushing pilots are examined by means of different shades of colour thrown upon a black background: while Ostend pilots have a number of pieces of wall-paper, or skeins of wool, of different shades of colour placed before them, and these they are required to group into the colours of the spectrum, a copy of which is placed before them.

Duly considering the various modes of conducting the examination practised by other nations, the Board of Trade came to the conclusion "that there was nothing in the colour-tests, or mode of applying them, as adopted by other countries, which, for practical purposes, is an improvement upon those in use in this country." But while it is thought to be undesirable to make any alteration in the mode of applying the colour-test in this country, it is admitted to be necessary to apply it more generally, and that "an examination in colours is needed, not only for officers, but for pilots and men on the 'look out.'" This will scarcely be made compulsory on all alike so long as shipowners affect to despise, or disbelieve in, the dangers arising from colour-blindness. An ignorant determination to reject all proofs on this score bars the way to the adoption of preventive measures.

As to the results of the past four years' examinations, from May, 1880, to May, 1884, when the colour-test was made compulsory, a great many curious mistakes, it appears, were made in colours by the 85 candidates who presented themselves for certificates: not all of whom were rejected, for 29 applied to be re-examined, and ultimately succeeded in satisfying the examiners. It should be observed, however, that the greater part of them were re-examined in provincial towns, and were said to be able to distinguish between red and green. Beside these 85 failures, there were also

55 failures reported in examinations for colours only. This, I assume, implies that a number of persons voluntarily offered themselves for the colour-test certificate before going to sea, and paid their shillings to satisfy themselves of their inability to distinguish colours commonly in use.

Many typical cases of complete and incomplete colour-blindness are given, and the subjoined summary more clearly shows the particular mistakes made by the 85 candidates already referred to.

Colours of cards or glasses.	Green.	Red.	Yellow.	Blue.	Other colours.
Green described as	—	79	16	13	13
Red ,,	24	—	3	3	3
Yellow ,,	9	38	—	1	2
Blue ,,	45	2	1	—	4
Black ,,	4	2	—	—	3
White ,,	3	1	—	—	—

Since the report does not state the total number of persons examined within the year, or the past four years, I am unable to give the exact percentage of rejections; but it may be assumed that it does not greatly differ from that of 1877 and 1878, which was rather under ½ per cent. It is believed that last year it stood rather higher, 0·56 per cent.

The hereditary nature of colour-blindness is a curious feature in the case. It is apparently known to but comparatively few persons that colour-blindness is transmissible, affects the human race in different degrees, is an incurable physical affection, and remarkable enough is chiefly confined to the male branch of families. A select instance or two from among many will serve to impress the first feature on the memory. In a family of seven children, four sons and three daughters, the sons are more or less colour-blind. The defect in this case is inherited from the grandfather, through the mother, whose vision, as also that of her three daughters, is quite normal. In another family of five children, three sons and two daughters, the sons inherit the colour-blindness of their father and grandfather, while the two daughters, and, indeed, all the females, for three generations at least, have been free from any colour defect.

My reason for referring to the hereditary nature of colour-blindness is that I wish more particularly to enforce a duty upon parents, one they owe to themselves and their children, that of making due inquiry into every peculiarity or defect of vision which may have constituted a family failing, before

yielding to the wish of a son for a sea-faring life. The inability of a boy to distinguish colours commonly in use should at once settle the question of his taking to the sea at all.

Colour-blindness is, to some extent, aggravated by age, just as is the case with certain other defects of vision. It apparently may be developed in after life, and as the near point of vision recedes. The Academy at this moment furnishes abundant examples, and which seem to justify the criticism that "yards of garish canvasses wanting in ideas, composition, drawing, and colour" cover its walls. To what other cause, if not to a great deterioration of the colour-sense, or to colour-blindness, can this great falling off in the works of artists be attributed?

As to the physical nature of colour-blindness, no entirely satisfactory explanation has been offered. Hering advanced a plausible theory that colour is the mental perception of the changes taking place in the visual substance, which, under the influence of light, is constantly undergoing a double process of disintegration and reparation. Perception of white light being coincident with disintegration; of blackness with re-integration; the degrees of white and black depending on the activity of the processes of disintegration and repair. But of the many theories promulgated, that known as the Young-Helmholtz is regarded as the most acceptable. According to this theory, the retina has three kinds of colour-perceiving elements, the stimulation of which gives respectively the sensation of red, green, and violet. White light excites all the elements equally, but if monochromatic or homogeneous light be received upon the retina, then each of the three kinds of fibres are simultaneously stimulated, and with an intensity that varies with the length of the waves. Thus, red light, which has waves of the greatest length, stimulates the red elements strongly, the green more feebly, and the violet only slightly, consequently the sensation experienced is red. Green, which has waves of intermediate length, stimulates the red and the violet feebly, and the green elements strongly, and the sensation perceived is green, and so with the violet, which has waves of the shortest length, and which acts as a powerful stimulus to the violet elements of the retina, and scarcely affects the green and red elements at all.

From what I have stated it may be understood that there are three kinds of colour-blindness corresponding to the three colour-perceiving elements: red blindness, green blindness, and blue or violet blindness. Of the several layers of which the retina is made up, it is the layer of rods and cones

that is concerned in the production of light and colour. Schultz believes that they both serve as elements of light, although the perception of light is the more immediate function of the rods, while that of colour exclusively belongs to the cones; should these be congenitally absent or partly developed it follows that the retina, and consequently the eye, must be insensible to certain portions of the spectrum colour-blind.

The physical and physiological bearings of the colour sense are too vast and important to be disposed of within a brief space; I must therefore content myself by stating for the present that the range of human vision, like that of hearing, is subject to great variations in different individuals, and that a great disproportion exists between the actual number of natural colours and the limited amount of sensory colours. The conclusion to be drawn from this observation is, that, "normally every visual mechanism is physically and physiologically fitted to respond to but a small number of the great bulk of natural colour vibrations, and thus virtually proving that every such mechanism is truly colour-blind."—(*Oliver*). It has been said of Chevreul that he was able to distinguish 14,420 tones of colour; more recently, too, it has been found that the human eye is totally unable to receive all the vibrations of colour which must exist in the spectrum. We know that it does not recognise the terminals of either end—the red and violet—and how many unrecognised natural colour differences actually exist between the red and the violet ends of the ordinary spectrum. Through the want of power of perception in the retina it is quite impossible to say or imagine.—(*Oliver*).

VIII. ON THE HUMAN TAIL.

ANTI-EVOLUTIONIST writers, who, as a rule, are not biologists, still concern themselves about man's supposed want of a tail. They have, indeed, been repeatedly told that the anthropoid apes are in this respect exactly on a level with man. If they were sincerely anxious for the the truth they might easily convince themselves that

this is the fact, and that the tail vanishes from the animal series before we reach that mythological "great gulf" which is supposed to separate beast from man. Yet they are not satisfied, and still persist, as in particular does the author of a work recently noticed in the "Journal of Science," in entangling themselves with this appendage.

Hence it may be useful if we lay before our readers some researches which M. H. Fol has recently submitted to the French Academy of Sciences. He asks, does the human embryo ever present at the posterior extremity of its body anything which merits the name of *tail*? This question must give rise to a discussion which cannot fail to be lively, unless we have previously made the necessary distinctions and have come to an understsnding on the strict definition of the terms employed.

It is necessary at the outset to distinguish teratological cases from the far more important phenomena of normal embryogeny which are about to engage our attention. Then we must agree as to the meaning of the word *tail*. Is this term applicable to every conical or cylindro-conical appendage at the posterior extremity of the back, whatever may be the tissues of which it is composed? Or should it be reserved for an organ containing a prolongation of the vertebral column? This latter definition seems to preponderate. An appendage devoid of vertebræ is not a true tail in the anatomical sense of the term, but merely a simple caudal prolongation.

In the monstrosities described by L. Gerlach, Bartels, and Ornstein, the appendage, whether filiform or voluminous, did not contain any evident undeniable vertebræ, and the total number of these bony structures did not exceed the regular number of a normal man.

As regards young embryos, an understanding is not possible if we do not first determine the point where the caudal vertebræ begin. Shall we fix the limit at the point where the tail branches off from the body? Or are we to be guided by the position of the anus? Or must we give the name caudal to all the vertebræ situate behind the sacrum? This last-mentioned view has prevailed in comparative anatomy, and from this point of view we may say that the adult man possesses a tail, since he presents four or five coccygian vertebræ, situate beyond the sacrum. The minimum, in this respect, is reached by the chimpanzee, which has only two or three coccygian vertebræ. This ape is consequently, when mature, further from possessing an externally visible tail than is the normal adult man—a fact not without significance.

If we apply the name of tail to the portion of the vertebral column which is situate outside the trunk of the body, it must be admitted that from the age of three weeks to that of two months and upwards the human embryo is endowed with this organ, for at this epoch the coccygial vertebræ occupy the axis of a cylindro-conical appendage, which is very apparent, and which issues from the posterior extremity of the trunk. If with His we take the position of the anus for a guide the tail will be less long, but is still very conspicuous, especially at the age of five to six weeks.

But it is generally admitted as absolutely demonstrated that this caudal appendage of the human embryo never contains any other vertebræ than those found in the coccyx of the adult. Ecker, who gives, in full conviction, the name of tail to the posterior extremity of the human embryo, has declared that he has never met with any supernumerary vertebræ. This author has even studied the well-developed tail of a human embryo 9 millimetres in length, and he describes and figures all the terminal part as consisting of an amorphous blasteme. His, however, detects here a prolongation of the dorsal cord and of the spinal marrow, but no segmentation. Both these authorities admit that beyond the 33rd or 34th vertebræ there is no further portion of the skeleton.

On this point the researches of M. Fol have led him to a result diametrically opposite to that of his predecessors. The error of His is due to the circumstance that the oldest embryos which he has examined, those of 7 millimetres have exactly 34 myomeres, that is to say 33 vertebræ; and he admits, without any further proof, that this was their ultimate condition.

M. Fol presented to the Academy a summary of his anatomical study of a human embryo of 5·6 millimetres, *i.e.*, of 25 days old. This embryo had as yet only 33 somites, representing 32 vertebræ. There is, therefore, an increase in number in the fourth week. This fact led M. Fol to examine if the number did not go on increasing during the fifth week, and his expectation was not disappointed. The human embryo of from 9 to 10 millimetres, the age when the tail attains its greatest prominence, possesses a *greater number of vertebræ than the adult.*

Two embryos of the finest appearance, and perfectly fresh when sent to the author, were first photograped and then cut into sections. The series of slices are irreproachable, and one of the two, comprising 320 sections, has been most carefully drawn in the camera lucida, in its totality. On

comparing these 320 figures it is easy to count, without any chance of error,—1, the rachidian ganglia; 2, the myomeres; 3, the nascent cartilages of the bodies of the vertebræ. These three enumerations check and confirm each other, since they all three give the same result: *the human embryo of eight to nine millimetres has thirty-eight vertebræ.*

This result is further confirmed by an examination of the photographs of the recent parts, since we readily distinguish 35 myomeres, and besides a region occupying the external fourth part of the tail where the demarcations are no longer visible through the skin. But the sections show us that in ... last quarter, contrary to the opinion of Ecker and His, the mesoderm is most distinctly divided into a double range of somites extending to the very tip of the tail, presenting dimensions regularly decreasing to the 38th somite, which measures merely 37 micromillimetres in diameter.

This fact is not teratological; it is fully confirmed by various other embryos which I possess, all perfectly normal, but slightly differing in age.

With the exception of the last two all the caudal vertebræ have a blasteme of cartilaginous substance, similar, except in size, to that of every other vertebra of the series. The last two are only indicated by myomeres, perfectly distinct from the rest. The extremity of the tail is formed by the termination of the medullary tube, covered merely by the skin. The dorsal cord extends, therefore, quite close to this extremity.

The last caudal vertebræ have but a very ephemeral existence. Already in embryos of 12 millimetres,—that is to say, of six weeks,—the 38th, 37th, and 36th vertebræ are blended together into a single mass, and the 35th itself has no longer very distinct limits. An embryo of 19 millimetres has merely 34 vertebræ, the 34th resulting from the fusion of the four last. At this moment the tail altogether is already much less prominent.

It results from these facts that the human embryo during the fifth and sixth week of its development is furnished with an incontestable tail, regularly conical, elongated, and deserving the name in all respects. It is deprived of all physiological utility, and must rank among the rudimentary organs.

ANALYSES OF BOOKS.

Elementary Text-Book of Entomology. By W. F. Kirby, Assistant in Zoological Department, British Museum, and Co-Secretary to the Entomological Society of London. London: W. Swan Sonnenschein and Co.

We have here a work which in some respects takes up ground not yet unoccupied. Accessible books on Entomology are for the most part devoted to some particular group of insects, or to the species inhabiting some particular country. Mr. Kirby describes all the groups of insects of the entire world. It is more systematic than the twin volumes by the Rev. J. G. Wood, "Insects at Home" and "Insects Abroad," freer from irrelevant reflections, and from the initial error of putting the insects of Britain—a group founded on a mixture of considerations, partly geographical and partly political—in antithesis to those of all the rest of the world.

The author in his classification recognises the seven "orders," as they are commonly called, Coleoptera, Orthoptera, Neuroptera, Hymenoptera, Lepidoptera, Hemiptera, and Diptera. He consequently rejects the separation of the earwigs from the Orthoptera as a distinct order (Euplexoptera); he includes the suggested order Strepsiptera among the Coleoptera; he assigns to the Heteroptera and Homoptera a subordinate rank as divisions of Hemiptera. He does not accept the strange proposal to form the Orthoptera together with the bulk of the Neuroptera into a new order, Pseudoneuroptera.

Mr. Kirby, however, is no believer in linear classifications. Indeed, as an Evolutionist, he regards every classification as merely provisional and approximate. He writes:—"Organic nature is now believed to have grown up into the form in which we see it from infinitesimal beginnings, by the effect of gradual changes acting and reacting on each other in the course of countless ages. We have consequently nothing before us to classify but the extreme ends of a vast tree, of the rest of which we are scarcely able to catch even the slightest glimpse. Consequently, while every group and every species is more or less related to others, a book arrangement can only be linear, and while it expresses a certain amount of affinity between the groups and species placed in juxtaposition, it likewise tends to conceal the fact that equally important affinities frequently exist

between other species or groups which may chance to be widely separated in our necessarily artificial arrangements."

We have been disposed to quote the above passage not as containing any absolutely novel conception, but as being fairly representative of the manner in which the organic world appears to those who are constantly in the habit of studying it, not in books, but face to face; unless indeed they are blinded by early prepossessions and *à priori* notions,—fragments of the official mantle of Cuvier, which remaineth upon the eyes of the "Section of Zoology and Anatomy" of that most bureaucratic body, the French Academy of Sciences.

The following passage may be commended to the many who seem to mistake the scope of Entomology:—"The collector's province may be exhausted in a few years; but the observers, never."

From the immense extent of the subject it has been, of course, impossible for the author to describe every species, or even every genus. He has been compelled to restrict himself in every family to the most characteristic forms. We note that in his arrangement of beetles he places the Brachelytra not as is done, *e.g.*, by Stephens, at the end of the order, but next after the Palpicornia. A well-known carrion beetle, lately known as *Oiceptoma thoracica*, is restored to the original genus *Silpha*. The genus *Typhæus*, however, is retained for the black three-horned dung-beetle of Epping Forest. The locality given for *Purpuricenus Kœhleri* is "as far north as the southern slopes of the Alps." These limits require extending; two specimens in our possession we captured near Neuwied, on the Rhine.

When speaking of the earwig, Mr. Kirby tells us that he has heard of perfectly trustworthy cases in which this insect has entered the human ear.

Among the exotic species of insects which have succeeded in becoming acclimatised in England is the little yellow Brazilian ant, *Diplorhoptrum molestum*. Its introduction does not seem to date back beyond the present century. This fact gives a certain weight to Mr. Kirby's caution that certain species of Termites may possibly naturalise themselves in our midst.

The illustrations to this work are numerous, and, although not coloured, are well fitted for their purpose. There has been no attempt to make them into ornaments. In our opinion Mr. Kirby has executed his task—evidently a labour of love—in a very satisfactory manner.

Notes on the Meteorology of the South Australian Alps. By JAMES STIRLING, F.L.S.

THIS memoir, which is a reprint from the "Transactions of the Royal Society of Victoria," has been courteously forwarded to us by the author. It contains a series of observations made at Omeo, and is a very useful contribution to the meteorology not merely of Australia, but generally of the Southern Hemisphere,—a subject in great need of more extended study.

Mr. Stirling began his observations in 1879 at Omeo. The exact altitude of this place does not seem to be given, though we should conclude from various data that it is more than 2000 feet above the sea-level. He has also collected returns from settlers living in the mountainous region around, and has erected instruments at Mount St. Bernard, at the elevation of 5036 feet. Mr. Boustead is in charge of this latter station. We learn that snow falls at heights exceeding 2000 feet. Wheat can be successively cultivated at elevations between 2500 and 3000 feet; and cabbages, green peas, and other esculent vegetables, up to 5000 feet. The author considers that these higher regions of Australia offer a splendid field for investigating many interesting meteorological changes. He suggests the establishment of a chain of high-level observatories from the Western Australian ranges across South Australia, and the summits of the Australian Alps to the Blue Mountains in New South Wales.

The average rainfall at Omeo is 24·18 inches yearly. The average number of wet days in the year is 96, the maximum being 114, the minimum 84. The greatest mean rainfall for any month is in October, 3·47 inches. The moisture-laden winds are the south-westerly and north-westerly. The average annual snowfall at Omeo is 2 feet 3 inches, and at Mount St. Bernard (5000 feet) 14 feet. Near the summit of Mount Kosciusko (7200 feet) it is probably 50 feet. Hail is frequent during summer and autumn in the higher regions, but less common at the sub-alpine altitudes, though the size of the hailstones is often larger, between 2000 and 4000 feet, than at greater heights.

The yearly average of cloudiness, judging from observations made at 9 a.m. daily, is—clear days, 123·4; cloudy, 184·8; and overcast, 55·8. The clear days are, however, in the majority during the summer. It is, we think, by the way, a mistake for meteorologists to divide the year into four equal seasons. The respective length of the seasons is a phenomenon depending upon latitude, altitude, proximity to the ocean, &c. Now, as in Omeo there are on the average seventeen frosty days yearly, which may occur from May to September inclusive, we should be inclined to say that Omeo has five months winter. July,

answering to our December, is the most inclement month, having a minimum temperature of 19° F. The mean annual is 53° 34′ F., or better by about 4° than that of the South of England. The maximum heat registered at Omeo is 105° F., so that the absolute range is 86°. By some clerical or typographical error it is made 128°. Here, as in the United States and in England, it has been observed that exotic plants often flourish on the ridges whilst perishing in the valleys, to which the cold air flows down.

At Omeo it would seem that spontaneous evaporation is in excess of rainfall.

The author—as well as Mr. Griffiths, and subsequently Dr. Von Lendenfeld—has detected evidence of a Glacial epoch in the colony of Victoria, probably in the Post-Miocene. On this subject the author announces a paper, which we hope to have the pleasure of noticing.

On the Mechanical Characters of Lightning Strokes. By Col. the Hon. ARTHUR PARNELL, late Royal Engineers.

IN this pamphlet, the reprint of a memoir read before the Royal Meteorological Society, and inserted in their "Quarterly Journal" for January, 1855, the author argues from facts that physical force, as manifested in mechanical work, is a principal characteristic of lightning strokes. Indeed, as far as his own observations and the evidence which he has collected go, mechanical work is their main effect. It would appear that the more powerful the stroke, the less heat effect is produced. The cases tabulated show 1221 instances of mechanical work as against only 485 of heat work. Col. Parnell conceives of lightning as "a luminous manifestion of the explosion caused by two equal forces springing towards each other simultaneously from the earth and the under surface of the inducing cloud, and coalescing or dying out nearly midway between the two plates of the electrical condenser formed by the earth and the cloud." He also holds, upon the strength of a number of observations, that 'of these two forces it is the "earth-sprung or upward force alone which injures persons, buildings, or other objects on the Earth's surface, and which constitutes tangibly what is rightly known as a lightning-stroke."

It is certainly, on the commonly-received view of lightning-strokes as coming from above, remarkable that history presents so few cases where the injury must necessarily have been inflicted, and so many where the force must almost beyond doubt have acted from beneath. It is much to be desired that, in future cases of

lightning-stroke, the nature of the damage done should be more carefully examined than has been hitherto generally done.

We remember, long ago, going to inspect a cottage near the Droylsden Copperas Works, Manchester, which had been wrecked by lightning in a very complicated manner. We can distinctly call to mind our being very much puzzled to trace the course of the flash, assuming that it must have come from above, since the damage appeared to be subdivided in passing from the floor towards the roof. Once, when weather-bound at a country inn, we took up, to pass the time, a novel by G. P. R. James, in which a terrible storm is described in which the strokes ascend. The author, as far as we recollect, stated in a note, or in his Preface, that the possibility of such an occurrence having been questioned he had referred the matter to an eminent physicist,—we believe Sir David Brewster,—who, in reply, stated that upward lightning-strokes were by no means unprecedented.

On the Origin and Reproduction of Animal and Vegetable Life on our Globe. By THOMAS SPENCER, F.C.S., F.R.M.S., &c. London: Effingham Wilson.

MR. SPENCER, we believe, is an inventor and discoverer whom for some occult reason the world has thrust aside, giving the credit of his results, as regards the purification of water, to another. In connection with electro-metallurgy, of which he was our pioneer, his name is now rarely, if ever, mentioned. He seems to share the fate of Dr. Walker in the matter of sanitary reform, and of Thomas Grey as concerns railways. The treatise before us does not, however, deal with these subjects. Its object is to show the action of magnetic iron-oxide in effecting the combination of oxygen with carbon at common temperatures, in presence of moisture. His observations have further rendered it extremely probable that this oxide exists in every reproductive germ, animal or vegetable, and exists, too, in a state of the highest activity. At least, as Mr. Spencer informs us, he has in twenty years' search never failed to find in seed germs iron-oxide in combination with water. Even the soil, he shows, in the absence of iron-oxide is sterile. In demonstration he recommends the attempt to grow seeds in a soil carefully freed from oxide of iron, as compared with a similar soil containing iron. Mr. Spencer contends that the leaves of plants do not absorb aërial carbonic acid, but only sufficient oxygen for its formation. But whence, then, comes the oxygen which they give off? He states that if a healthy growing plant is put in an

atmosphere of carbonic acid it dies. But does it not perish also if carbonic acid is entirely excluded?

In the formation of carbonic acid in this manner, heat and electricity are, according to the author, always liberated, and without them life-force would be wanting.

Mr. Spencer pronounces magnetic oxide as the only body in nature "that possesses a *quasi* principle of motion of which it cannot be deprived without chemical dissolution. It is also in itself the most fixed oxide in Nature, though its particles are the most volatile known and ever in imperceptible motion."

Comparative Vocabularies of the Indian Tribes of British Columbia. By W. Fraser Tolmie and G. M. Dawson. Montreal: Dawson Bros.

This compilation is issued under the auspices of the Geological and Natural History Survey of Canada, and is illustrated with a map showing the distribution of the tribes concerned, who occupy a territory of about 200,000 square miles to the west of the Rocky Mountains. A singular fact is noted in the Preface. Along the coast line there is a striking diversity of languages, which is somewhat puzzling among tribes maritime in their habits, skilled in navigation, and thus enjoying great facilities for mutual intercourse. In the interior of the country, on the contrary, where, from the rugged and densely wooded character of the region, intercommunication is comparatively difficult, the languages have a much wider extent.

Records of the Geological Survey of India. Vol. XVIII., Part 2. 1885.

This issue contains some important matter. Mr. R. Lydekker, F.G.S., establishes a second species of fossil camel (*Camelus antiquus*) from the Siwaliks. It is distinguished from *C. Sivalensis* by its smaller size, the perfectly smooth enamel of the teeth, and the concave surface of the lower true molars, the upper half of which is divided into two equal portions by a median vertical ridge, which is totally wanting in *C. Sivalensis* and in the existing camels.

Col. C. A. McMahon, F.G.S., contributes Notes on the Geology of Chambra. He produces evidence that the Himalayas

have been slowly rising, whilst the rivers have been deepening their channels. Thus there is no necessity for assuming that the River Siul ever flowed at the elevation at which the boulder-bed now rests. Such boulders now lie at the top of the Chandon Namo Pass, at the height of 12,340 feet above the sea-level and 2400 feet above the present bed of the Spiti.

The flora of these regions is not uninteresting. A poppy of a delicate purple-blue merging into white is common above the zone of trees, but the author has never observed it at lower elevations than 11,000 feet. Wild rhubarb abounds at the head of the valleys. The stalks are consumed by English explorers and sportsmen, but whether the root is pharmaceutically valuable we do not learn. There are many species of Fungi growing on the trunks of trees. According to the natives all the Fungi parasitical on the oak are wholesome, whilst those growing on pine trees are to be avoided. Col. McMahon made a dietetic experiment with one of the former, which he found not unpalatable. He adds:—"On opening my eyes next morning I was thankful to find myself still in the land of the living."

The inhabitants of these upland regions are not believers in cleanliness. The author writes:—"The process of washing my face and hands in the morning was a source of great delight to a group of village maidens, who in these mountain villages seem wholly unacquainted with the cleansing properties of soap and water." The geologist in the Himalayas has to contend with difficulties. Here is a specimen:—"The torrent under Budra has cut a deep narrow gorge through the mountain; descent to the water's edge was impossible, and the only way to cross the stream was by a frail bridge stretched from rock to rock some 150 or 200 feet above the roaring torrent below. The bridge was formed of these poles about 30 yards in length, and across them small roughly hewn planks were fastened with twigs, forming a roadway of about a yard in width. A plank was dangling by one end over the chasm below, leaving a gap in the roadway, and suggesting painful doubts regarding the stability of the rest of the structure. The bridge had neither railing nor hand-ropes."

Mr. R. D. Oldham discusses the probability of obtaining water by means of Artesian Wells in the plains of Upper India, and comes to the conclusion that there is no zone of coarse permeable deposits continuous with those of the *bhatar*, and that in consequence there is little prospect of obtaining water in this manner in the plains of Upper India, except in small quantities.

Mr. H. B. Medlicott replies, considering the difficulty raised by Mr. Oldham rather imaginary, and re-affirming his conviction that there is a reasonable prospect of success. He urges that the trials hitherto made have been fixed upon solely on grounds of local need, and not as being in any degree favourable sites for testing the conditions.

Mr. F. R. Mallet examines the prevailing opinion that the

Arakán Mud Volcanoes burst into eruption chiefly during the wet season. An examination of the recorded eruptions would seem to point to the reverse conclusion, as ten of the thirteen have taken place in the five dry months, and only three in the seven wet months. The author, however, does not consider that the observations made are sufficiently numerous to warrant a generalisation.

Mr. F. R. Mallet gives an account of the phosphatic nodules and rock of Mussorea. They are of a very suitable quality for the manufacture of manure, as the nodules contain 34·70 per cent of phosphoric anhydride and the rock to 30·16, equal respectively to 75·75 and 65·84 tricalcic phosphate.

Chemical Science and the Voice. An Address delivered by Dr. Carter Moffat at the Second Ammoniaphone Concert, June 12th, 1885, under the direction of Col. H. Mapleson.

The Ammoniaphone is a somewhat startling invention. By breathing through it a few times daily "the voice becomes much stronger and richer in quality, while a very large amount of good is done to the respiratory apparatus. By taking a few inhalations every day for a time the husky voice is made clear, and the weak delicate throat and lungs strong." Further, "to use the instrument now and again prevents to a great extent the user taking colds. The susceptibility to chills and throat and chest affections disappears." If certain "highly volatile antiseptics"—not named—are added to the vapours and gases ordinarily inhaled from the instrument, "we have a sure and certain remedy at hand for stopping hæmorrhage from the lungs."

Thus this instrument appeals to two distinct worlds, the musical and the medical. Whether it possesses the merits claimed for it practical experience alone can decide. We are told that the invention "is being used by numerous members of the Royal family, as well as by the Prime Minister and leading parliamentary men." We should be inclined to think that if this invention leads to an increase of speech-making, with which we are already overstocked, Dr. Carter Moffat will have but very slender claims upon public gratitude.

Turning now to the theory of the invention, we read that Dr. Moffat has found hydrogen peroxide and ammonia in the air and dew of Italy, and to these constituents of the atmosphere he ascribes the superior quality of the voice commonly met with, as it is supposed, among the natives of that country. But unless we are much mistaken hydrogen peroxide—hydroxyle as it is

called by the gods—has been found in the air of every country where it has been carefully sought for. The same may be said of ammonia. The question then arises whether hydrogen peroxide and ammonia are found in larger proportions in the atmosphere of Italy than in that of other regions? We do not know of any analytical evidence to that effect, and Dr. C. Moffat does not supply any such in the lecture before us. One fact renders the abundant existence of hydrogen peroxide in Italy somewhat questionable, *viz.*, the prevalence there of malaria. Surely, if so efficient an antiseptic as hydrogen peroxide were exceptionally abundant in Italy, zymotic diseases ought there to be exceptionally rare.

A second question which we are unable to discuss is whether Italian voices really possess any well-marked superiority?

It may be, however, that Dr. Moffat's device may be practically useful, though founded upon a questionable theory.

Supplement to "Euclid and his Modern Rivals." Containing a Notice of Henrici's Geometry, together with Selections from the Reviews. London: Macmillan and Co.

THIS pamphlet is a criticism on modern text-books of geometry, presented in the form of a dialogue, or rather a trial at law. "Minos" has been retained by the ghost of Euclid to represent his interests, while Herr Niemand—a German professor—appears as counsel for Henrici and others.

The first incongruity is that the advocate on one side is represented as cross-examining the advocate on the other. Whether this method of presenting an argument is the best means, or even a good means, of arriving at truth is very questionable. He is a very poor man who cannot, if so disposed, put untenable arguments into the mouth of an imaginary opponent.

Mr. Dodgson then reviews the reviewers of his former treatise, with whom as a body he feels little satisfied. It is hinted by some of them that the esoteric object of the treatise is to uphold the interests of University examiners. Thus Mr. J. Magnus ("Educational Times") is quoted as saying, "But surely it must be admitted that methods of teaching a subject ought not to be considered from the standpoint of examinational requirements." Who will dare to say that in England not merely the methods of teaching, but the very subjects taught, are selected with reference to this point of view?

Text-Book of Structural and Physiological Botany. By OTTO W. THOMÉ, Rector of the High School, Cologne, and ALFRED W. BENNETT, B.Sc., F.L.S., Lecturer on Botany at St. Thomas's Hospital. Fifth Edition, revised and corrected. London: Longmans, Green, and Co.

WE have here a most useful Manual, somewhat the worse, however, for the very extensive references to examinations, and the mode of preparing for them, which are encountered both in the "Preface to the Fifth Edition" and in the "Editor's Preface." All such books, in reality, enforce the painful truth that a thorough knowledge of any subject and the ability to "pass" in it are not necessarily identical, the one being able to exist independently of the other. But without discussing the evidence on this subject, to which the British official mind is obstinately and wilfully blind, we must pass on to the work itself.

The authors, in the very outset, fully recognise the impossibility of fixing, in any definite manner, a boundary line between animals and plants, and the difficulty—to use the mildest term—of a natural classification: they then give a history of the science, omitting, however, all mention of Lindley, Bentham, St. Hilaire, Robert Brown,—who was styled by a German contemporary "botanicorum facile princeps,"—the two Hookers, Asa Gray, Boussingault, and Darwin! These omissions the editor supplies in a footnote, in which room might have been found for Ettingshausen, Heer, and Von Müller.

Passing over the successive chapters on the "Cell as an Individual," the "Cell as a Member of a Group of Similar Cells," the "Construction of the Plant out of Cells," and the "External Form of Plants," we come to a very full and ably written account of the "Life of the Plant." Here we find it stated that the nutrient substances of the plant—in other words, plant-food—are "carbon, oxygen, nitrogen, hydrogen, and sulphur," to which must be added "iron, calcium, potassium, magnesium, and phosphorus." The relative importance ascribed here to these elements scarcely agrees with that assigned to them by the farmer and the gardener.

Viola calaminaria is mentioned as an instance of a plant which always contains zinc, and which will grow on zinciferous soils only. To the widely diffused presence of copper, *e.g.*, in the cacao tree, there is no reference. The manner in which plants which live on decaying organic matter absorb their food, and are nourished, is pointed out as a problem still unsolved. As regards the alleged assimilation of free nitrogen, the authors, in common with the leading agricultural chemists of the day, take the negative view.

The fact that plants have a true respiration, in which oxygen

is absorbed and carbonic acid given off, and that consequently in an atmosphere of pure carbonic acid they are suffocated, as are animals, is brought into notice. This is of the more importance since many well-educated persons still apply the term "respiration" to the process in which plants take up carbonic acid and give off free oxygen.

In speaking of nitrogen, the authors say "Whether non-parasitic plants absorb nitrogen also in the form of certain organic compounds is still undetermined." This error the editor corrects by reference to the carnivorous plants, such as *Drosera*, which absorb through their leaves nitrogenous substances "by a process of true digestion, precisely analogous to the digestion of animals, due to the presence of a ferment analogous with pepsine."

The function of insects in the fecundation of plants, and the habit of bees to visit in succession many flowers of the same kind, so that the pollen is not wasted, are admitted as fully established.

The effects of temperature, both upon germination and the maintenance of plant-life, are considered at some length. The editor adds in a footnote that some fungi, bacteria, and fungus-spores are able to withstand a temperature of nearly or quite that of boiling water. From the experiments of Dallinger and Drysdale it would appear that certain microphytes are not killed at temperatures below 300° F.

The authors do well to point out that the term "chemical rays" of light, as applied to the blue, violet, and ultra-violet radiations, is inaccurate and misleading, and should be abandoned. We do not see that, whilst expounding the effects of light upon vegetation, they mention that an excess of light, even when unconnected with heat, is distinctly injurious.

We are somewhat surprised to meet with the statement (p. 194) that in hybrids "the power of propagation is commonly defective, and they are often altogether infertile." Many observers, including the eminent botanist Prof. Meehan, maintain, on the contrary, that among vegetable hybrids fertility is the rule and sterility the exception.

The abnormal vital phenomena of plants, and their consequent abnormal developments, are very ably described. The same must be said of the peculiar diseases of plants, chiefly due to the attacks of vegetable and animal parasites.

As believers in the sugar-cane and its true sugar, we are not sorry to learn that a destructive fungus has attacked the beet. Eagerly as we long for the rout of the phylloxera, the potato-disease, and the blights affecting the coffee and the peach-trees, we hope no less devoutly that the beet disease may spread, and that "betose" may disappear from the earth.

In the section on "Special Morphology and Classification" we must note the very considerable space now devoted to the

Thallophytes since the importance of the part which they play in the economy of nature has come somewhat into notice.

The chapter on "Botanical Geography" naturally suggests the question how it is that the distribution of plants cannot, as it would seem, be brought into harmony with that of animals. If we take the system given by Mr. A. R. Wallace in his "Geographical Distribution of Animals" we find six grand regions, each subdivided into provinces, or divisions of an inferior rank, making altogether 24 provinces. The differences between the regions are plainly of a higher importance than the distinctions between the provinces of any one region.

In Griessbach's geographical classification here adopted we have no regions, but merely 24 provinces of equal rank. The boundaries, too, are far from coinciding. The neotropical region of Sclater and Wallace would include 7 provinces, not 4, as in animal geography. Griessbach makes a "region of Oceanic Islands," in which New Zealand, Madagascar, Feejee, the Azores, &c., figure along with the Falklands and Kerguelen's Land.

Here the authors do not attempt to show any common feature which should warrant countries so distinct in their flora being classed together. The Australian region of Griessbach does not coincide with that of Wallace. The former confines it to Australia proper and Tasmania, while with the latter it includes also New Zealand, the Eastern Islands beyond "Wallace's line," and the Pacific Islands.

These discrepancies are very unsatisfactory. If we consider to what an extent the fauna of any country depends upon its flora, and how greatly both fauna and flora are influenced by the same factors, we shall feel that there is here urgent need for further investigation.

From the point of view adopted by the authors, or rather we should say by Mr. Bennett, the work is excellent, and will render great service to that somewhat rare animal the true student, as well as to his mimic, the man who is preparing for an examination.

The Mount Morgan Gold Deposits. By R. L. Jack, Geologist to the Queensland Government.

The discovery of gold in and near Mount Morgan, in Queensland, is of extraordinary interest, as the deposits are in an unusual formation. The author thinks that nothing but a thermal spring in the open air could have deposited the material in question. The gold and the accompanying iron may have been dissolved out of the "Mundic Reef," the gold possibly by chlorine produced

by the contact of the pyrolusite present in the ironstone of Mount Morgan, with hydrochloric acid from the decomposition of chlorides. The siliceous sinter, containing in some cases as much as 10 ozs. 14 dwts. gold per ton, gives evidence of former geyser action. The hot spring is supposed to have originated subsequently to the formation of the desert sandstone.

The author thinks this discovery important, not merely from the large quantity of gold actually found, but as indicating that palæozoic reefs rich in gold extend under the cretaceous rocks in the western interior of Queensland.

The Museum. An Illustrated Monthly Journal for Collectors of all Classes and Young Naturalists. Vol. I., No. 2, June, 1885. Philadelphia: W. F. Fill and Co.

One portion—and one portion only—of this new journal has our hearty good wishes. As it ranks among its contributors men of such merit as Prof. Jos. Leedy, Dr. C. C. Abbott, and Mr. Herman Strecker, it can scarcely fail to give satisfaction to naturalists if they get a fair share of space.

We notice in the issue before us a biography of the illustrious American palæontologist, Prof. E. D. Cope. "Curious Facts about Snails," by E. A. Barber: the author mentions a shell of *Helix Cooperi* which had its coils turned to the left instead of to the right, as in the normal structure of the species. We are not quite content to dismiss this phenomenon as a "freak of Nature." "Philately," however, which is a newly coined word for the collecting of postage-stamps, is quite outside our scope.

Our Corner. Vol. V., No. 6, June 1, 1885.

"Work for the Microscope," by Mr. J. Horner, is a sound, plainly written introduction to the use of this important instrument of research, and will doubtless guide not a few persons to its intelligent employment.

"The Heretic at Burlington House," by W. Greatheed,—a somewhile contributor to the "Mason College Magazine,"—seemed the possible title of irreverent criticisms on the learned societies established in that far western locality; but we find it a survey of the Exhibition at the Royal Academy, and as such

falling in bulk outside our scope. But the last few lines we must quote with approval. Mr. Greatheed objects to "Mr. Armitage being allowed to fill up the dome of St. Paul's Cathedral with the common angelic monstrosities, devoid of the necessary complement of pectoral muscles. When will painters dissect out in a pigeon the organs of flight?" To the naturalist the sight of a human figure with a pair of wings fixed on about the shoulder-blades is a sight anything but pleasant.

"Science Corner" is brief, but interesting. Emmering, of Laningen, is quoted as saying that bees always show signs of irritation on the approach of a thunderstorm. According to M. Miklucho-Maclay the temperature of *Echidna hystrix* is only 28° C., and that of *Ornithorrhynchus paradoxus* 24·8° C., the mean body temperature of other mammals being 38·4° C. This the Editor justly regards as a piece of evidence in favour of the truth of Evolution.

The Ecclesiastical Gazette. Vol. XLVII., No 564, June 15, 1885.

We are unable to discover why this paper has been sent us, as it contains no intelligence on subjects which lie within our scope.

As a proof of the watchful and untiring malignity of the Bestiarians we quote the following passage:—At a meeting of the Church Missionary Society "A letter was read from Miss A. Marston, dated 95, Onslow Square, on the subject of vivisection in its possible bearings on medical missions. It was resolved—'That the question of vivisection not having come practically before the Committee, they do not feel themselves called upon to give any opinion on the subject of Miss Marston's letter; but they have the most perfect confidence in all their medical missionaries, and feel sure that they will never permit, either directly or indirectly, any proceeding of an inhuman character to be carried on.' The Secretaries were directed to send a copy of this Resolution to every medical missionary connected with the Society." Are we equally vigilant in defence of Science?

CORRESPONDENCE.

*** The Editor does not hold himself responsible for statements of facts or opinions expressed in Correspondence, or in Articles bearing the signature of their respective authors.

PROCESSION OF CATERPILLARS.

THE other day, whilst walking over the plain here, I came upon a string of long hairy caterpillars, of a whitish, or rather pepper and salt, colour. They were following each other so closely that a little way off it looked like a big snake. No matter what was in the road, they kept strictly together. The procession was at the very least 12 feet long.

O. H. L. SLATER.

Port Augusta, South Australia.

THE WILD BIRDS PRESERVATION ACT.

To the Editor.

SIR,—Allow me to ask the question why it is that the above Act appears to be in some districts comparatively a dead letter? I happen to live in such a neighbourhood where this law is allowed to be broken with impunity, although we have a policeman to enforce it. What I refer chiefly to here is "birdnesting," which is not only destructive to the brood of our "meadow songsters," but is also most annoying to the farmer, who has the mortification of having his fences trampled down by perhaps a dozen boys. Should a farmer be seen crossing the road with his gun, the police will in this instance be down upon him. Now what I say is this: if we observe one part of a law and discard the rest, as in this case (for a farmer is not allowed to shoot birds), let us do away with such an Act altogether.—I remain yours, &c.,

SUB-ROSA.

May 25th, 1885.

[We copy this letter from the "Warrington Guardian" in proof that we are not singular in pronouncing the "Wild Birds' Preservation Act" a dead letter.—ED. J. S.]

NOTES.

THOSE who advocate the use of insects as food should remember that many insects contain cantharidine, formic acid, and other irritants not as yet studied.

According to "Science" the desecration of the Falls of Niagara has been stopped; the buildings and mills have been cleared away from the American shore and from Bath Island, and all points of view thrown freely open to the public. The cost to the State of New York has been 1,433,429 dollars.

"Light" speaks of the Witch of Endor as an "ancient medium."

A new chemical laboratory and museum are to be built in connection with Cambridge University at a cost of £70,000. But will the students be encouraged to undertake chemical research, and will such research, if successful, be a passport to honours?

Mr. W. H. Babcock ("Science") gives a case of a telephone wire having for a long time given forewarnings of storms, from six to twelve hours in advance.

Dr. J. Foster has recently read, before the Bradford Medico-Chirurgical Society, a very important paper on the physiological aspects of education. He remarked that the physiologist and the schoolmaster are at issue:—"The former will consider how he may best develope the brain and fit it for future usefulness; the latter, how he may get the most work out of it in the present." . . . "To enable the scholar to answer questions is not to educate him." The paper is an authoritative condemnation of the "results" system in education.

Why is it that, to men of culture, the females of the lower races of mankind are generally more repulsive than the males?

We must again urge our readers to do their utmost to prevent the return of any Bestiarian to Parliament at the approaching election.

The balance of the Darwin Memorial Fund, after paying for the statue and medallion, will be made over to the Royal Society to be invested, and the dividends or interest to be applied for the promotion of biological research.

Mr. C. Morris (Philadelphia Academy of Natural Sciences) regards the air-bladder of fishes as a degenerated organ, which

formerly to some extent performed the function of a lung, enabling fishes to visit the land.

At the last meeting of the Biological Society of France M. Brown-Sequard gave some instances of allocheirism, an alteration of sensibility in which a touch or an injury on the right side of the body is felt at the corresponding point of the left side.

Claude Bernard, we are told, was a confirmed spiritualist.

The appearance of the swallows this year in France has been —Beaucaire and Pendensac (Gironde), March 23rd; Vendôme, March 31st; Poitiers, April 1st; Parc St. Maur, near Paris, April 4th; and Dunkirk, April 16th.

According to the "Brewer's Guardian" 25,000,000,000 gallons of carbonic acid are yearly emitted into the atmosphere of Britain from the fermentation of malt liquors.

We are sorry to find that the "Economical Section" of the British Association is not yet marked for amputation.

J. F. James ("Science") shows from the first appearance of early flowers that in the Ohio Valley—just as in England—the spring of 1885 has been abnormally late.

We have omitted to put on record the death of C. T. E. von Siebold, founder of the "Zeitschrift für Wissenschaftliche Zoologie."

A statue of Linnæus was formally inaugurated at Stockholm on May 13th.

According to Hindu legends the successive incarnations of Vishnu ascended from lower to higher forms; first a fish, then a tortoise, a boar, a lion, a dwarf (ape), &c.

A. Gruber ("Biolog. Central-Blatt") has succeeded in dividing and re-dividing Infusoria (*Stentor cæruleus*) until sixteen individuals, each perfect, were produced from the original subject. Segments without a nucleus healed after the operation, but never became perfect animals.

German sanitary authorities are vainly seeking to combat Trichinæ and their evil effects by a more rigid inspection of all swine slaughtered for food. The remedy lies with the public; let them desist from the use of raw ham, "hackfleisch" (chopped raw pork), and "speck-salat," and the mischief will be at an end.

Count de la Croix de Vaubois, who has eaten preserved locusts at Ouargla, thinks that they might have been good if the oil had not been rancid and mixed with sand.

According to the Bulletin de l'Académie Royale de Belgique"

the poison of the scorpion is opalescent, possesses a faintly alkaline reaction, contains in suspension a great number of fine rounded granules, and seems analogous to the echidnine of the poison of vipers. It seems to be a poison like curare, acting on the nerves of motion, but not on those of sensation.

"Cosmos" raises the question how it comes that so few dead elephants, and indeed wild animals generally, are ever found?

The same journal refers to a great number of cases of madness, said to have occurred some years ago, after spiritualistic experiments.

Anti-vaccinationists will, we fear, be little edified with the conclusions of the German Commission on the Vaccination question which have been recently submitted to the Reichstag:—

1. One attack of smallpox, with rare exceptions, confers immunity from the disease.
2. Vaccination affords similar protection.
3. The duration of this protection varies within wide limits, but amounts on the average to ten years.
4. To obtain sufficient protection two developed marks are needful.
5. Re-vaccination should take place after the lapse of ten years.
6. The vaccination of the surrounding population increases the relative protection of the individual, and vaccination has therefore not merely a personal but a general value.
7. In vaccination with human lymph the danger of the transfer of syphilis, though small, is not absolutely excluded.
8. Since the introduction of vaccination there has been no demonstrable increase of diseases which can be regarded as a consequence of vaccination.

Mr. Edward M. Nelson remarks ("English Mechanic," No. 1052, p. 247, May 22, 1885) that "while the literature of the celestial telescope is extensive, and correspondence frequent, that somehow or other the terrestrial telescope has been left out in the cold." The paper describes the properties of the telescope proper, and how it differs from the Galilean binocular field-glass now so much in use. For every purpose, except use at the theatre and on board a steamer,—where the vibration renders the use of the long telescope difficult,—Mr. Nelson considers the latter in every way superior, and remarks "that a pair of binoculars is often given as a present or a prize, quite regardless of the fact that a pair of binoculars is like a pair of boots—to be of use they must fit. So important is it that the centres of binoculars should exactly correspond with the centres of the eyes of the persons using them that the slight divergence of even 1-16th of an inch is quite sufficient to detract from the pleasure of using them. Further, it is stated that the nearest approach to optical

perfection must be sought for in a lens whose focus = 15 times its aperture. What shall we say, then, of the binocular field-glass the focus of whose objectives does not exceed 3 times their apertures." "It is a sad fact that at the present day the terrestrial telescope, apart from the navy, is only to be found in the hands of scorers for rifle-shooting, and of a few infatuated individuals who still persist in carrying about these antiquated instruments." Mr. Nelson gives a good account of the most useful kinds of telescopes made; also their respective uses, and what kind of performance may reasonably be expected from them. Very full directions are given for the testing of terrestrial telescopes, and the reader is put on his guard against two very common defects,—error in the size and position of the diaphragm in the erector, and the cutting off of the aperture of the object-glass by the insertion of stops. Only those who have made use of a good small telescope know what can be done with it. It is one of the field naturalist's most valuable tools: an animal can be watched, the face of a cliff examined, plants detected, geological details noted, and, if the focussing slide is long enough, an observation can be taken at as short a distance as 20 feet; the view given is surprising, the details of flowers and insects are rendered in a manner almost microscopical, and the picture rendered brilliant by its isolation from all surroundings; and the instrument doing all this will give a splendid view of the moon, and show Jupiter's satellites and Saturn's ring.

J. Schlesinger ("Zeitschrift des Œster. Ingenieur-Vereins") maintains that the doctrine of the inertia of mass is an error, and attempts to explain all mechanical and other physical phenomena by assuming that space is an absolutely persistent and fixed substance penetrable by all the real things of the world, and that energy is also a substance penetrable by all the real things and moving in a capillary manner in the fixed substance of space. [The term "real" is here taken in its philosophical sense.]

The total number of licenses for physiological experimentation during 1884 was 49, and the number of experiments performed was 145. Of these 99 consisted simply in the introduction of a virus; 24 were experiments in cases of suspected poisoning; 10 were experiments on the action of certain Fungi upon fish, and 5 on the effects of absolutely pure water upon fish. [So much for the "cutting up alive."]

The French Association for the Advancement of Science will meet at Grenoble, August 13th, 1885, under the presidency of Prof. Verneuil.

M. Richard ("Comptes Rendus") has examined the effect of cocaine upon the pulmonic gasteropods, earthworms, crustaceans, hydræ, &c.

According to Dr. Gordon the circulation of the blood was familiar to the Chinese physicians 2000 years ago.

M. Magnan cites a number of cases of madness among Bestiarians. One woman first renounced animal food, then took in all stray dogs, and finally went round to the butchers begging them not to slaughter any more cattle. She became formally mad, and was received as a patient at Charenton.

Prof. Dewar and Dr. Tidy, after having undertaken for their own satisfaction a prolonged inquiry into the working of the "A B C" Sewage Process as carried on at Aylesbury, have issued a Report, of which the following are the principal points:—

1. That the A B C Process produces a clear effluent free from suspended matter and devoid of smell.
2. That the effluent is uniform notwithstanding the very varied nature and concentration of the sewage.
3. That as the strength of the sewage increases the precipitation is more complete.
4. That the Process removes over 80 per cent of the total oxidisable organic matter.
5. That it precipitates 60 per cent of the organic matter in solution, and of the residue left in the effluent at least two-thirds are non-albuminous, and therefore of a nature less liable to putrefactive and other changes.
6. That the Process is carried on without nuisance, the sewage being immediately and completely deodorised, and the entire Works free from any objectionable smell.
7. That it produces a manure containing an average of 3·8 per cent of ammonia calculated on the perfectly dry manure, and also 5 per cent of phosphates reckoned as tricalcic phosphate.

A disgraceful instance has recently occurred of a poor woman being compelled, by School Board persecution, to send one of her children to school while some others of her family were suffering from measles! Such things are the inevitable outcome of the "payment by results."

The "Philadelphia Call" quoted in the "American Naturalist," gives an interesting case of a dog feeling ashamed of a dishonest act. It "saw a cutlet near the edge of the board, and yielded to the temptation to steal the meat. The cutlet was slily seized and taken under the sofa, the dog's owner pretending not to see the theft. But the conscience of the little terrier got the better of its hunger: it brought the cutlet back, laid it at the feet of its master, hung its head in shame, and slunk away."

Prof. H. N. Mosely, F.R.S., contends that all the main groups of the animal kingdom first came into existence along the shores of the sea,—in the so-called littoral zone,—and that here also the first attached and branching plants were developed. But

both the animals and plants of the shores were probably derived from pelagic ancestors.

Prof. A. W. Rücker, F.R.S., from an investigation of liquid films, arrives at the conclusion that the diameter of a molecule is considerably less than 2×10^{-6} millimetres.

We must hope that the Platypus will not be extirpated before its life-history has been completely worked out. Mr. Caldwell is searching for them, and has obtained in six weeks 500 specimens.

Dr. Aurivillius finds that the uniformity of the Arctic fauna becomes more striking as we approach the Pole, but that three subdivisions are manifest,—the Scandinavian, the Asiatic, and the American.

M. Felix Lucas, in a recent study on the radiations of incandescent carbons, shows that the electric arc-light *decreases* in luminosity if the electric intensity or the temperature are carried beyond a certain limit. The radiations become first red, then white, and finally pass into the ultra-violet, where they no longer act upon the human sight.

V. Horsley, F.R.C.S., in a lecture delivered at the Royal Institution on the "Motor-Centres of the Brain and the Mechanism of the Will," showed that as a rule both cerebral hemispheres are engaged at once in receiving and considering one idea; that under no circumstances can two ideas either be considered or acted upon attentively at the same moment; that the brain is a single instrument, and that our idea of our being single individuals is due entirely to this single action of the brain.

Mr. J. S. Kingsley has revised the inter-relationships of the arthropods. He finds that the arachnids are more closely allied to the crustaceans than to the hexapods and myriapods, with which they are usually classed. The arachnids and the hexapods have little in common, and the diviston Tracheata is artificial and not natural.

"Light" says "The limitation at present placed on natural laws must be relaxed."

Holland, it seems, is blessed with a Society for the Prevention of Cruelty to Animals, which body has petitioned the Government to introduce the restrictions on physiological experiments drawn up by the Prussian authorities,—restrictions not so bad as those in force in this country, but which certainly concede too much.

A new form of Psychography has made its appearance, to which we call the special attention of conjurors and exposers. A blank sheet of paper and a clean pen nib are laid between two slates, and on the upper slate is placed a heavy inkstand. After a short time the upper slate is lifted off, when the paper is found covered with writing and the pen wet with ink. Who will solve this riddle?

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